Electronic Engineering

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EE 36 002 *for further details*

farnell

TRANSISTORISED
VOLTAGE
REGULATED

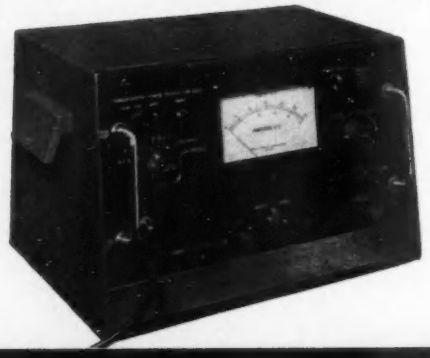
POWER SUPPLY UNITS

TSV 30/5 EC

With Electronic Cut-Out and External Sensing

Input Voltage:	110-220 volts with taps 5, 10, 20 volts on both ranges. 40-60 c/s.
Maximum Output Current:	5 amps. continuous.
D.C. Output:	0-30 volts D.C. and continuously variable.
Case Dimensions:	15" long x 11" deep x 10 high (with feet).

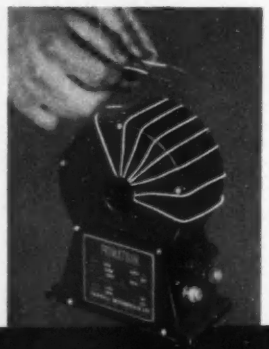
U.K. Price: £94



A New Portable Toroidal Primary Transformer

PRIMATRAN REGD.

- ★ **Never obsolete—any voltage—any time.**
- ★ **Useful for demonstrations of transformer principles to students.**
- ★ **Ideal for laboratories, etc.**
- ★ **Inexpensive—many transformers from one primary.**



Why search through a shelf full of transformers . . . when the Primatran will meet most of your requirements.

The Primary is a Toroidal winding in a plastic moulding. A 3-pole input socket on one side of the moulding connects the mains to the primary, and when used as a current transformer enables the output to be obtained from the same socket. When used as a voltage transformer the secondary winding is wound round the outer case, and the ends of this winding are connected to two terminals on the other side of the plastic moulding. It is possible to wind a number of secondaries on the Primatran for obtaining various secondary voltages simultaneously.

NB

See our advertisement on page 118 for further details, or send for literature.

FARNELL INSTRUMENTS LIMITED

LIGHT INDUSTRIAL ESTATE · YORK ROAD · WETHERBY · YORKSHIRE

Telephone: Wetherby 2691/2

Vol. 33 No. 402

AUGUST 1961

Electronic Engineering

Incorporating ELECTRONICS, TELEVISION and SHORT WAVE WORLD

Managing Editor: H. G. FOSTER, *M.Sc., M.I.E.E., M.Brit.I.R.E.*

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PUBLISHED MONTHLY on the last Friday of the preceding month by:

MORGAN BROTHERS (PUBLISHERS) LIMITED
at 28, Essex Street, Strand, London, W.C.2.
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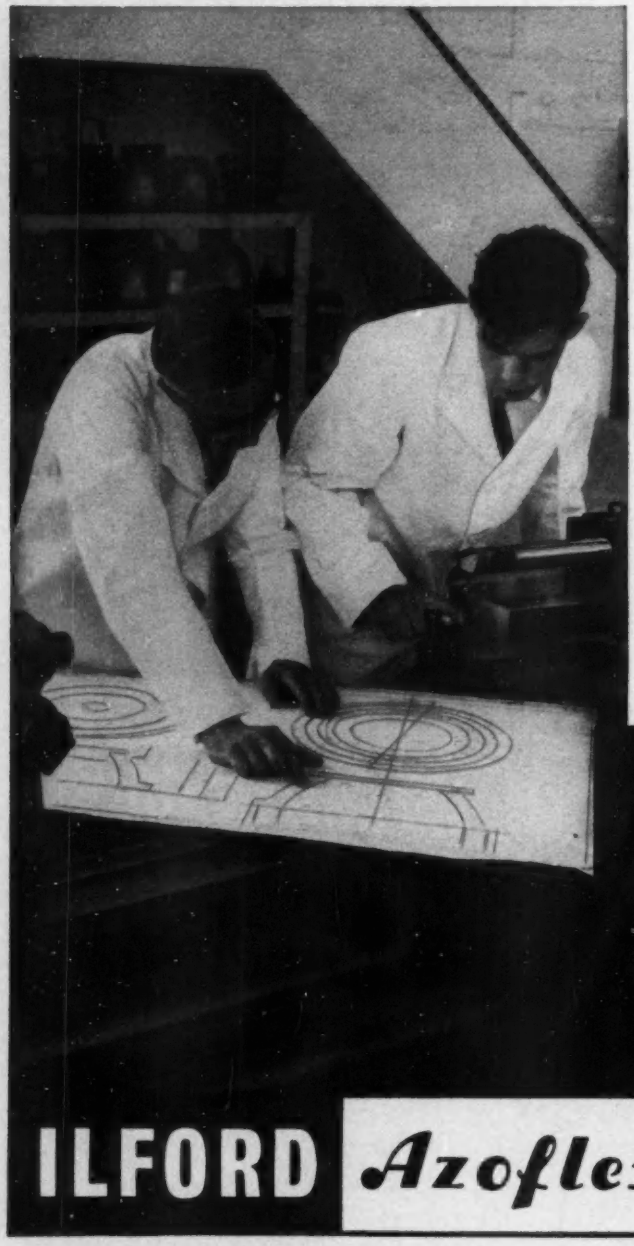
EE 36 005 *for further details*

Workshop angle and D.O. viewpoint



Now that machining costs are so high, the legibility of working drawings has become of supreme importance. ILFORD Azoflex photoprinting papers give maximum legibility combined with speed of production and long life in normal storage and use. That is the workshop angle combined with the viewpoints of the drawing stores and D.O.

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Many business and industrial concerns find that it pays to hire certain AZOFLEX machines — rather than buy them outright. Enquiries will be treated with the utmost discretion, and will not commit you in any way.

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FULLY SEALED and ENCAPSULATED

to withstand −55° C to +120° C

type A 4

PRECISION WIREWOUND RESISTOR

This new resistor is fully sealed and encapsulated and will meet the H1 Humidity requirements from −55°C to +120°C. The ceramic bobbin is in two sections to reduce the inductance.

Rating:	¼ watt.
Temperature Coefficient:	Better than ±0.002% per °C or better than ±0.0015% per °C above 1,000 ohms.
Long Term Stability:	Better than ±0.03% for the first 1,000 hours' use; thereafter, negligible.
Range of values and Best Tolerances:	0.1Ω to 1Ω ±0.01Ω 1Ω to 40Ω ±1% 40Ω to 100Ω ±0.1% 100Ω to 1 MΩ ±0.05%
Dimensions:	⅜ in. long by 1/16 in. diam.

Full technical data available from:
Diss, Norfolk
Tel.: Diss 2288

London Sales Office at
551, Holloway Road, London, N.19
Tel.: Archway 0014

Alma
COMPONENTS LTD

High precision resistance wire

VACROM
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These 'Vacrom' and 'Eureka' high precision fine and superfine wires are provided to meet the most accurate demands of the electrical industry. They can be supplied fully annealed in either a bright or oxidised finish in accordance with B.S. or to meet the customer's own specifications.

EUREKA
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* *Supplied bare or with standard coverings of cotton, silk, rayon, enamel and glass.*

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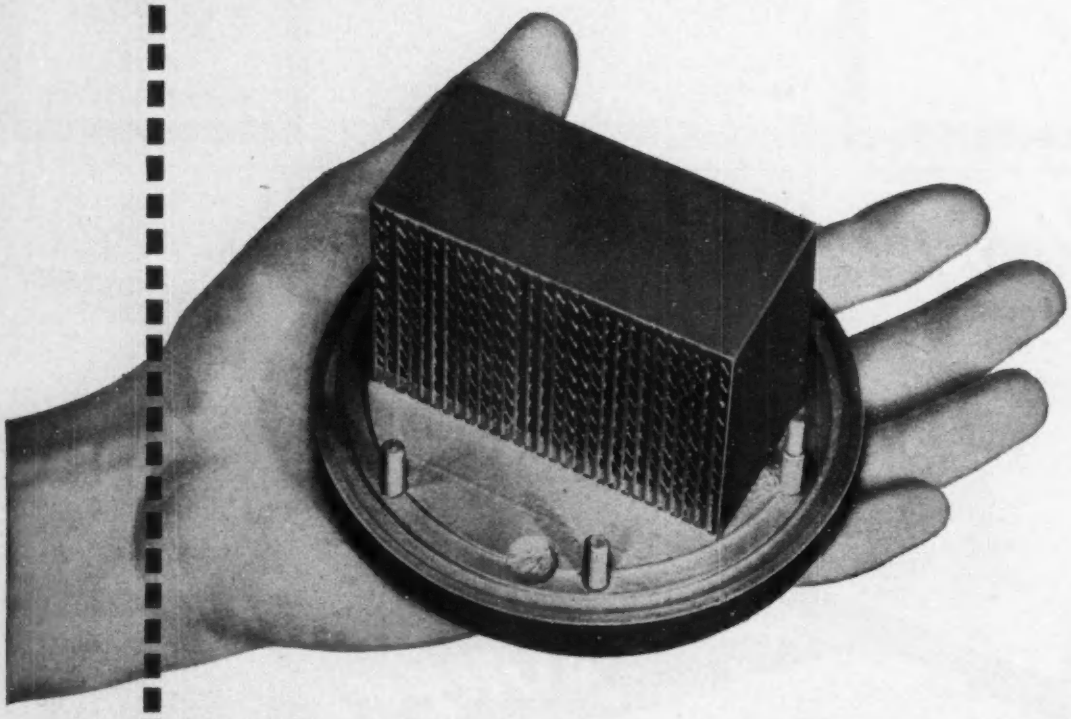
L.V.5

EE 36 008 *for further details*

COMPACT COOLNESS

In a sense it's an optical illusion. A magnetron valve cooler made by Marston sits snug in the palm of the hand—but, thanks to the ingenious corrugations of the secondary surface heat-exchanger, it presents two-and-a-half square feet of surface area. This is just one instance of the compact coolness Marston offers the electronics industry. Marston heat-exchangers, whether air- or liquid-cooled, are designed specifically for preserving component life and efficiency and reducing the drift of transistor characteristics. Don't design round these problems: Marston can help you overcome them.



MARSTON EXCELSIOR

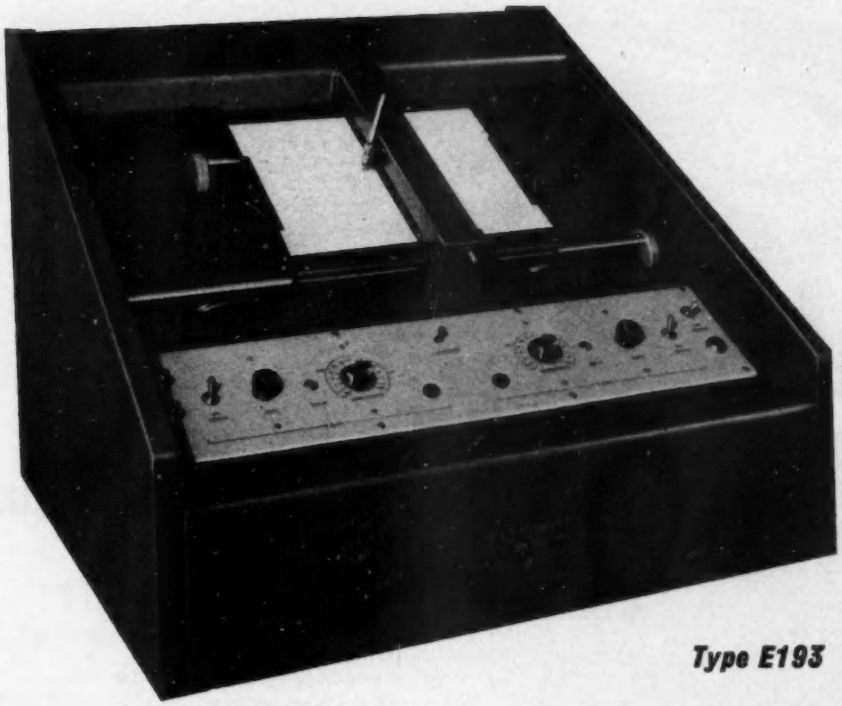
The Mark of Craftsmanship

ICI

MARSTON EXCELSIOR LIMITED, FORDHOUSES, WOLVERHAMPTON, ENGLAND

MAR 265

EKCO X-Y Recorder



Type E193

Ekco Type E193 is a high-speed X-Y Recorder which plots the relationship between two inter-dependent variables directly on to standard 10" x 7½" graph paper.

The wide sensitivity range (1 mV. per 1" to 50 V. per 1") and exceptionally fast response (full-scale travel in 200 milli-seconds) make it unusually versatile in the fields of performance investigation and process control.

This instrument will find wide use in research laboratories, industrial organisations and hospitals or in any field in which it is necessary to chart rapidly-changing parameters accurately.

Sales, Installation and Service

EKCO ELECTRONICS LIMITED

SOUTHEND-ON-SEA · ESSEX · Tel. Southend 49491

EE 36 010 *for further details*

PANELLIT I.S.I. 609

The I.S.I. 609 for a large Chemical Works. Shown are the five basic elements of the system.

1 Elliott 803 Digital Computer (Channel 1).
2 Control (Channel 2).
3 Computer Control Console.
4 Plant Operator's Console, with Control Panel and Visual Display.
5 Automatic Typewriter.

THE WORLD'S FINEST SYSTEM FOR AUTOMATIC PLANT MEASUREMENT AND CONTROL

offers **9** *unique advantages*

★ **60%–70% of Computer Time Free for OFF-Line Work.**
On-line operations rarely demand more than 30%.

★ **Automatic Programme Modification**—while machine is still running, and without disturbing remaining programme or stored information.

★ **Monitoring of Process Variables.**
Automatically records and audibly signals all off-normals.

★ **Fast Arithmetic.** Special unit operates on all process data in 2.8 milliseconds—even for square roots, a tedious operation in other computers.

★ **Continuous Logging of Process Inputs**—with all off-normals clearly indicated in red.

★ **Computation of Plant Performance.** Prints out results and gives alarm if performance falls short of estimated or calculated optimum.

★ **Automatic Plant Control.**
Automatically re-sets individual control loops to the optimum level.

★ **Analogue-Digital Conversion**—and vice versa.

★ **"Routine" Changes Without Interrupting Operation of System.**
The number of index registers for this purpose (most computers have very few) is almost *unlimited*. Programming of extremely complex problems is thus enormously simplified.

The use of solid-state components throughout plus continuous self-checking routines and fail-safe circuits make the Panellit I.S.I. 609 System the finest in the world and the ultimate choice of every discerning engineer. Our specialists will be pleased to call on you to discuss its application to your own work.

PANELLIT LIMITED
ELSTREE WAY, BOREHAMWOOD, HERTS *ELStree 2040*

A MEMBER OF THE ELLIOTT-AUTOMATION GROUP

P6

Birlec DRY FOR SAFETY VISION

Birlec air conditioning plant, incorporating a unique system of recirculating ducting and a Birlec COS type dehumidifier delivering 1500 cfm of dry air into the system, has been installed in the King's Norton factory of the Triplex Safety Glass Co., Ltd.

The air conditioning plant recirculates air round the room and introduces 550 cfm of fresh air into the system. 1750 cfm is passed to the dehumidifier for drying, with a moisture content of 2.6 grains per cubic foot and is returned to the system at 0.25 grains per cubic foot.

The Birlec air conditioning system aids the production of the highest quality glass of the type used in aircraft. Plastic 'interlayers' are assembled with the glass before being subjected to pressure to form an integral block. A thin film of gold acts as the conductor in the glass when electrical heating is necessary to prevent ice formation on exposed surfaces.

SM/B6404

AEI-Birlec Limited
Tyburn Road, Erdington, Birmingham 24
Telephone: East 1544 *Telex No: 33471*
LONDON · SHEFFIELD · NEWCASTLE-ON-TYNE · GLASGOW · CARDIFF

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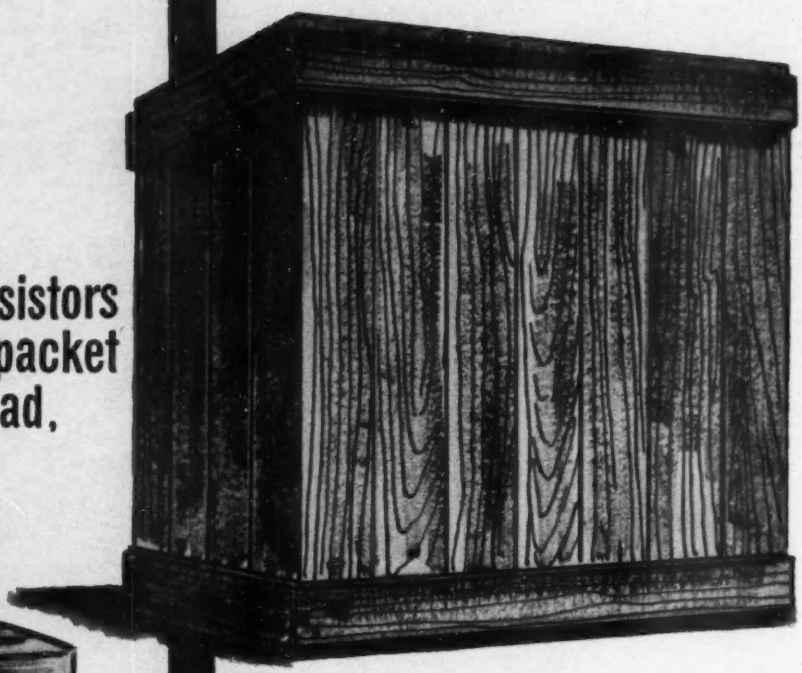
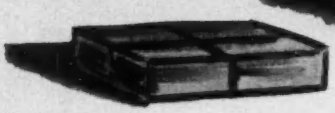
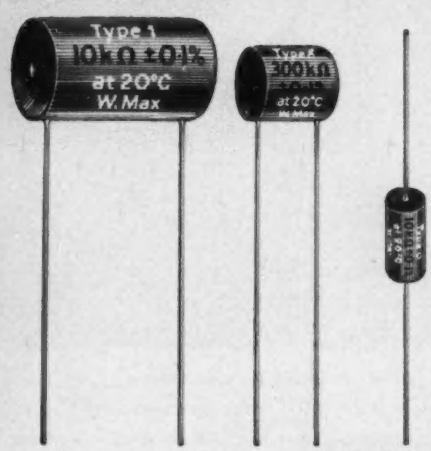
PRECISION wirewound resistors by the postal packet or the crate load, are made dependably by RIVLIN







STANDARD RESISTORS

TYPES P.201 & P.C.301 FOR PLUG-IN AND PRINTED CIRCUITS

ril

NEW ENCAPSULATION METHOD

Rivlin Instruments Limited have developed a new method of encapsulation, based on epoxy resin, which has the following advantages:—

Wide Temperature Range—Proof against High Humidity. Suitable for use in the temperature range −55°C to +120°C with or without humidity, without significant effect on accuracy and stability.

Improved Stability. The new method results in resistors having stability of a very high order.

Interchangeability. The new range is completely interchangeable with the existing RIL types (1-9) and all dimensions are exact and repeatable within close limits.

Precious Metal Plated Terminations. In accordance with the best modern practice, the terminations are gold plated for ease of soldering and to prevent oxidation during storage.

STANDARD RANGE

Rating ¼W to 3W. Range 1Ω to 3MΩ tolerance to ±0.1% of nominal value or 0.01Ω whichever is the greater. Terminals, wire leads or solder lugs, fixing studs can be fitted.

PLUG-IN

Rating ¼W (other ratings to order). Range 50Ω to 200KΩ, tolerance ±0.1%. Designed for rapid range changing in recorders, computing networks, voltage dividers, etc. Phosphor bronze pins, gold plated for low contact resistance, plug into Electro Methods type D2 socket (special spacings to order).

PRINTED CIRCUIT

Rating ¼W (other ratings to order), range 50Ω to 200KΩ, tolerance ±0.1%. Designed specifically for Printed Circuit use with Phosphor Bronze pins, gold finished, spaced to suit standard Printed Circuit module.

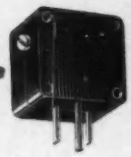
NEW PRODUCTION CAPACITY

By the recent completion of additional factory, laboratory and office buildings our capacity and scope have literally tripled. Delivery is now 3 to 6 weeks according to size of order. Where high accuracy and consistent performance are vital considerations then RIVLIN is the resistor to specify.

RIVLIN INSTRUMENTS LIMITED

Yorktown Industrial Estate, Doman Road, Camberley, Surrey.
Telephone: Camberley 2507/8 Grams: Rivlectron Camberley
London Office. Tel: Swiss Cottage 3038.

this illustration is actual size



SOME FACTS ABOUT THE NEW

RIVLIN

miniature

PRECISION PRE-SET POTENTIOMETER

its precision worm drive assures smooth adjustment without backlash ● its setting remains stable under vibration and shock ● its ratchet mechanism prevents overwinding ● it occupies only 0.11 cu. in. ● can be mounted vertically, in tandem side by side or stacked ● it is specifically designed for today's advanced electronic techniques ● conforms to BSI 3081

and here is its brief specification:

Resistance Range	...	10 Ω to 10k Ω
Tolerance	...	±10%
Rating	...	1w at 20°C, ½w at 70°C
Temperature Range	...	−40 to +70°C Ambient
Weight	...	0.1 oz.
Temp.: Co-eff.	...	Less than 20 p.p.m.
Mechanical Life	...	500 cycles (Slider).

ril

RIVLIN INSTRUMENTS LIMITED

Doman Road, Camberley, Surrey. Tel: Camberley 2507/8

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GD373

IE

modular transistorised high-voltage power

INTERNATIONAL ELECTRONICS introduce in *modular form* their well-proven range of High Voltage Transistorised Power Supply Units now employing Ministry Approved components. A rigid alloy framework encloses each unit and enables four, if required, to be mounted behind a standard 19″ x 7″ panel.

The length of any unit may be increased beyond the dimension stated if required to fit into existing equipment.

A large reduction in volume has been achieved without any sacrifice in performance; indeed, the ratings are now extended to allow operation at ambient temperatures of up to 45° C under suitable conditions of ventilation. The characteristics of low heat dissipation and excellent short circuit protection are, of course, retained.

The units may be set, by simple link-changing, to provide output voltages of 300V, 250V, 200V, 150V, or 100V. Special output voltages remain readily available to order.

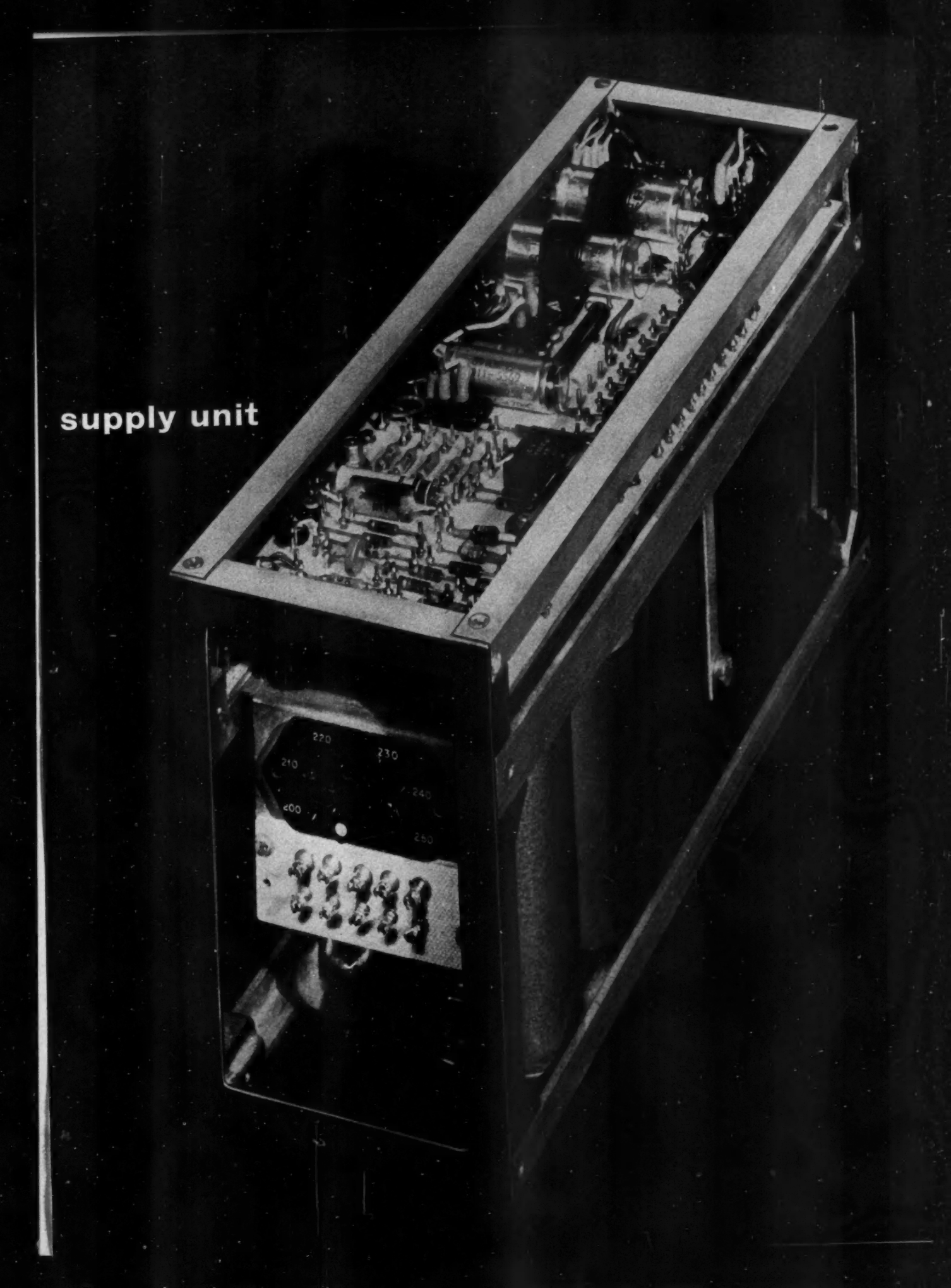
Electrical connection to the unit is normally made to turret lugs at the rear but plugs or sockets will be fitted as required.

Excellent accessibility is afforded by easily detachable heat sinks and by a plug-in component-board which runs the entire length of the unit.

International Electronics Ltd
132-135 Sloane Street London SW1 Telephone SLOane 1396

Type No.	Output Voltage	Output Current	Output Impedance to 500 Kcs less than	R M S ripple less than	Stability Factor	Size	Price
DSM1	100 150 200 250 300	100mA	.5ohm	1mV	400: 1	6¾″ × 4½″ × 11 1/16″ (min)	£47
DSM2	100 150 200 250 300	200mA	.5ohm	1mV	400: 1	6¾″ × 4½″ × 11 1/16″ (min)	£58
DSM3	100 150 200 250 300	350mA	.5ohm	1mV	400: 1	6¾″ × 4½″ × 14″ (min)	£71
DSM4	100 150 200 250 300	500mA	.5ohm	1mV	400: 1	6¾″ × 4½″ × 14″ (min)	£85

Provisional Patent No. 4670/60


supply unit
220
230
210
240
200
250

EE 36 016 *for further details*

1 PART IN 10^{10}

Not all the measuring equipment we offer has this accuracy. Not all such equipment need be this accurate, but what equipment we do offer is of the highest standards obtainable with time proven systems of circuitry and construction.

It pays all research laboratories and development departments to invest in the best.

Write for the ROHDE & SCHWARZ free catalogue. It contains a wide range of superb instruments. When you find something suitable, then please write for full specification. The rest is simple, ask for a demonstration either at your laboratory or at our works. (Our technical staff can assist you with any measuring problems which you have.)

All equipment is guaranteed for one year and full servicing facilities are available.

Aveley Electric Limited

SOUTH OCKENDON · ESSEX
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P.6270

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VIBRATION MEASUREMENTS

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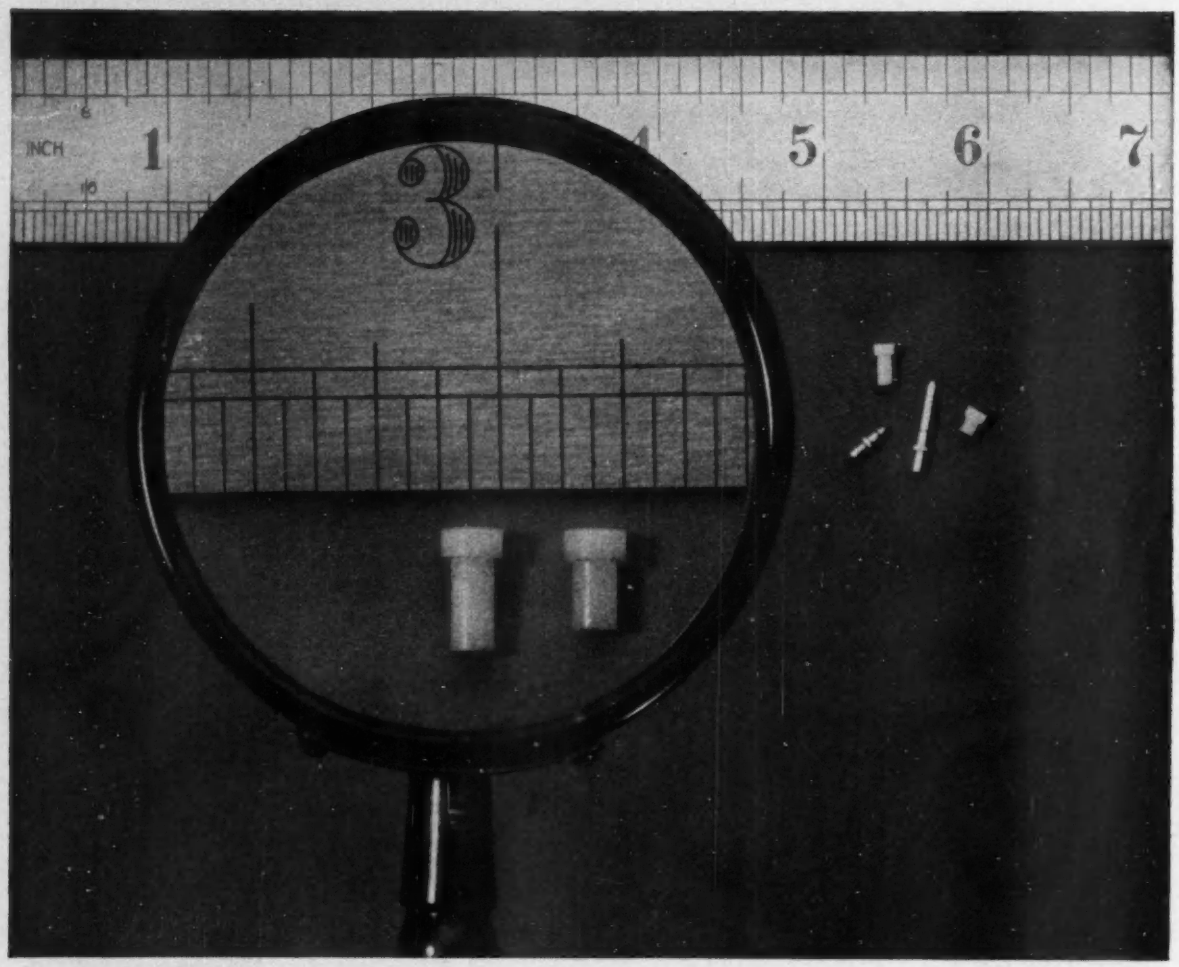
NOW CLIX QUALITY COMPONENTS AT COMPETITIVE PRICES



THESE POLYTAGS ARE MINIATURE IN PRICE TOO!

Clix prices keep going down, and on this range of miniature polytags, they've gone about as far as they can go. But there's nothing cheap about the specification, materials and workmanship—they're all up to Clix quality plus PTFE insulation and silver-plated brass contacts. This is an entirely new range—4 feed-through and 2 stand-off types—available in 11 colours for coding in accordance with BSS cable colour code. They're coming off of our greatly expanded production line in large numbers and we'll be happy to quote you for any quantity.

AEI **CLIX ELECTRONIC COMPONENTS**

Associated Electrical Industries Limited · Radio & Electronic Components Division · 155 Charing Cross Road · London WC2 · Telephone: GERrard 9797

CRC 17/4X

COOLING
FOR ALL
COMPONENTS
In electronic engineering *precise* temperature control is essential for the speedy and accurate measurement and analysis of data. This particularly applies in the field of all-transistorised electronic assemblies where the generated heat must be controlled to ensure absolute accuracy and efficiency of the equipment in use. This is where STERNE'S knowledge of refrigeration is invaluable; by the application of their wide experience they can provide the solution to many complex problems.
STERNE
REFRIGERATION
FOR ALL ASPECTS OF REFRIGERATION
L. STERNE & COMPANY LTD. The Crown Iron Works, GLASGOW.
Tel.: DOUglas 6461 (10 lines).
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Full Technical and service facilities available at the following branches:
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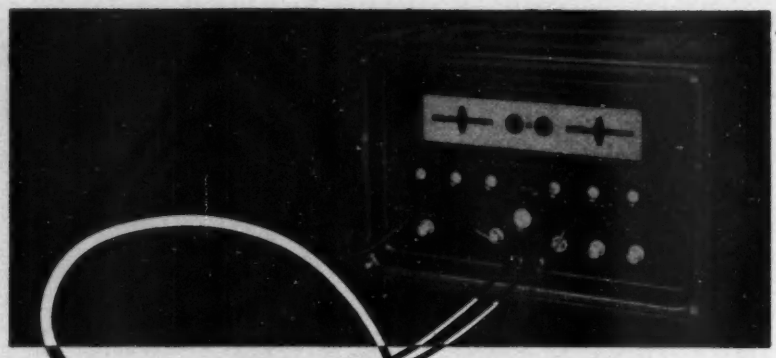
EE 36 020 *for further details*

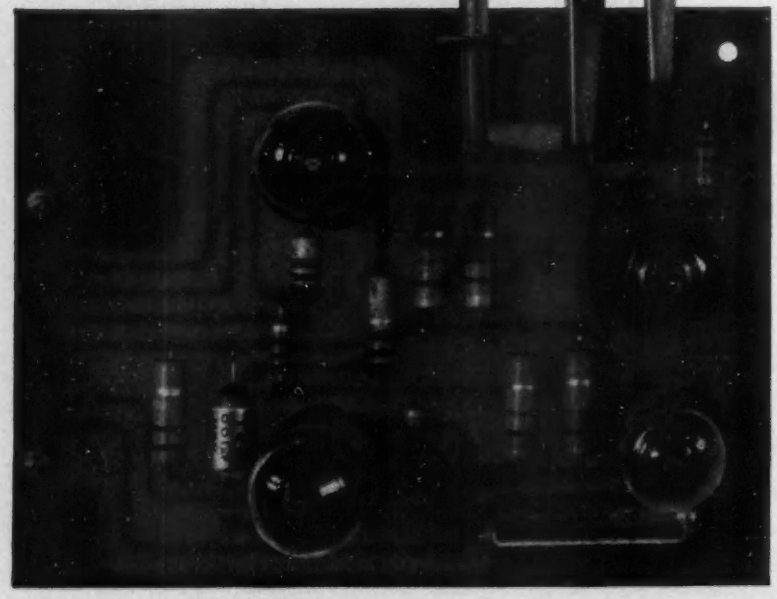


measuring 1pF - at the end of a lead as long as you like

Accurate, remote measurement extends dramatically the application of bridge techniques.

Measurement of the individual components of complex impedances to an accuracy of ±0.25%, without removing them from circuit, coupled with facilities for two, three and four terminal measurement, enable the Universal Bridge B.221 to be put to an almost limitless range of general industrial use.

The instrument will establish the characteristics of components and of circuits—further, special adaptors are available to cover the measurement of liquid conductivity, dielectric constants of solids and liquids, dry joints, switch contact resistance, circuit strays, boundary layer impedance of liquids, permittivity and loss factor of solids and liquids—and dielectric properties of liquids in test tubes.



Foolproof, direct reading dials

The Universal Bridge B.221 has as a special design feature the layout of the controls and displays. A novel mechanism automatically inserts the cyphers, decimals and units of measurement in the dial windows. Thus, the errors which may be caused by large multiplying factors are obviated. This facility means that the instrument may be used efficiently even by unskilled personnel.

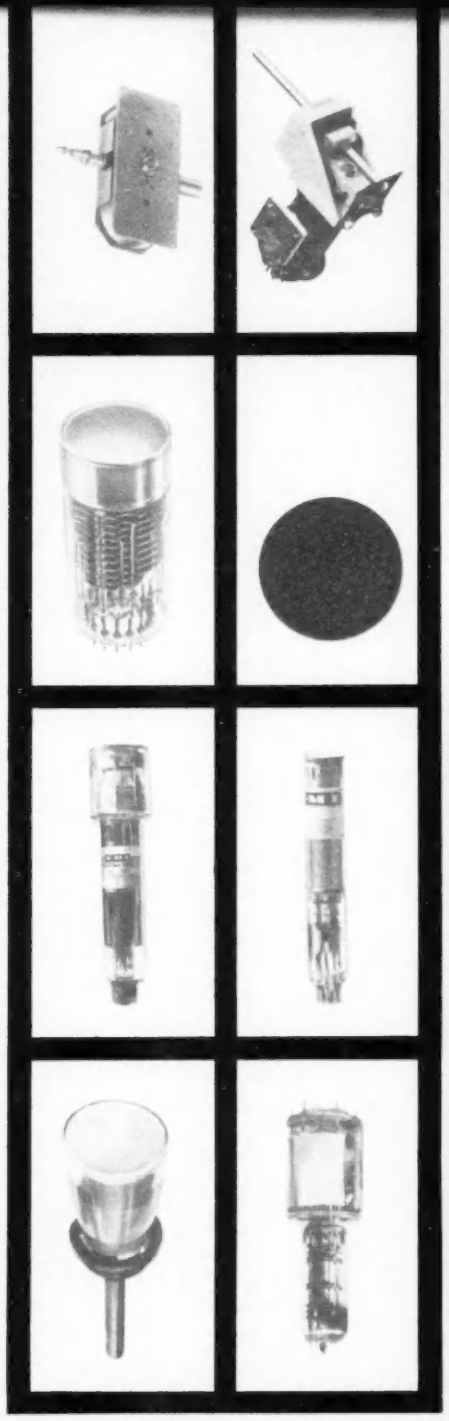
This instrument and its applications are fully discussed in Information Service Publication AB221—copies available on request.

THE WAYNE KERR LABORATORIES LIMITED
Sales and Service
44 Coombe Road
New Malden, Surrey
Telephone: MALden 2202

WAYNE KERR

Universal Bridge B221

WK4



In all their many applications EMI Electron Tubes give top rate performance

EMI electron tubes are used in broadcasting, radar, nuclear, scientific and many other professional applications.
They are precision manufactured to the highest standards of accuracy and EMI's research and development programme covers a wide range of new tubes and techniques. EMI is at the service of design and development engineers in solving application problems.

Reply card

Please send me further details of the following

- ☐ Photomultiplier Tubes and Photoconductive Devices
- ☐ Microwave Tubes
- ☐ Camera Tubes
- ☐ Cathode Ray Tubes and Storage Tubes

Also a copy of the:—

- ☐ EMI Klystron & Waveguide data selection chart
- ☐ Photomultiplier Tube selection chart
- ☐ I would like to receive regular information regarding new developments

NAME AND TITLE

COMPANY'S NAME

ADDRESS

EMI

EMI ELECTRONICS LTD
VALVE DIVISION . HAYES . MIDDX.
Telephone: HAYes 3888 Ext. 2165

EMI offers a very wide range of special tubes

These are brief details of some of the EMI special tubes. For further information please send the reply-paid card to EMI.

1 PHOTOMULTIPLIER TUBES AND PHOTOCONDUCTIVE DEVICES

EMI is the largest producer of photomultiplier tubes in Europe and these tubes are outstanding for very low values of dark current obtainable, with high gain, photosensitivity and stability of operation. They are supplied with various types of photo cathode for specific applications. 'S' cathode tubes for example are particularly suitable for carbon 14 and tritium counting. Solid state radiation detectors are also available for specialised applications.

2 MICROWAVE TUBES

EMI Reflex Klystrons include a wide range of plug-in klystrons and tuneable cavities giving continuous coverage from 3,000 to 12,000 M/cs. ('S' to 'X' band); a new, advanced design 'J' band tube is now in the late stages of development. Integral cavity types covering 'K', 'Q' and 'J' band, have improved tuner for good frequency stability and freedom from microphony. A 4 cavity, water cooled Klystron with a gain of 50 dB and capable of handling peak powers in 'S' band of 100 kW is also available.

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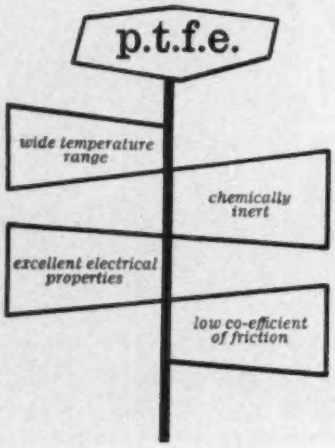

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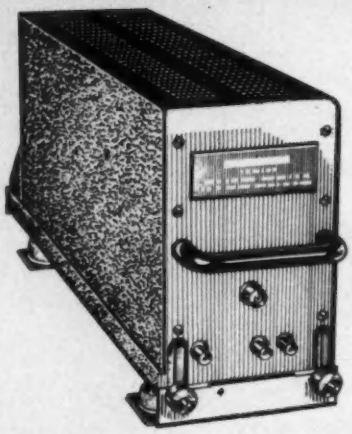

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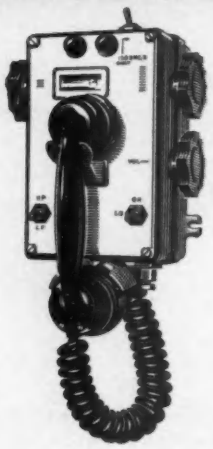

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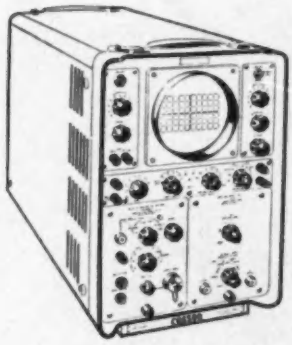

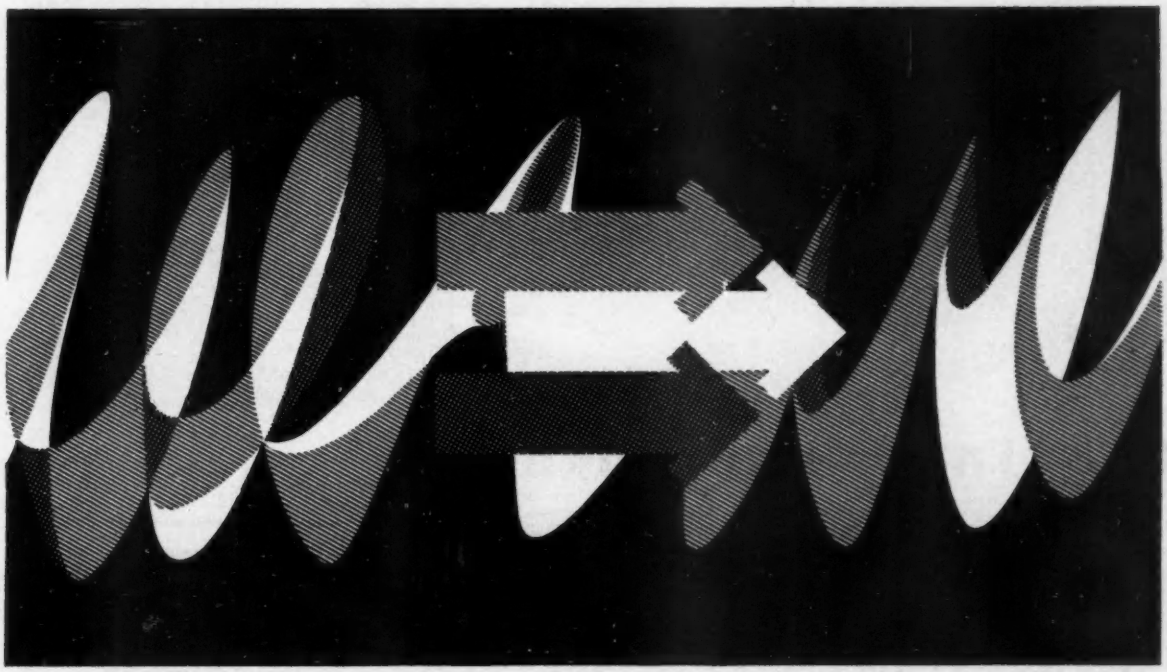

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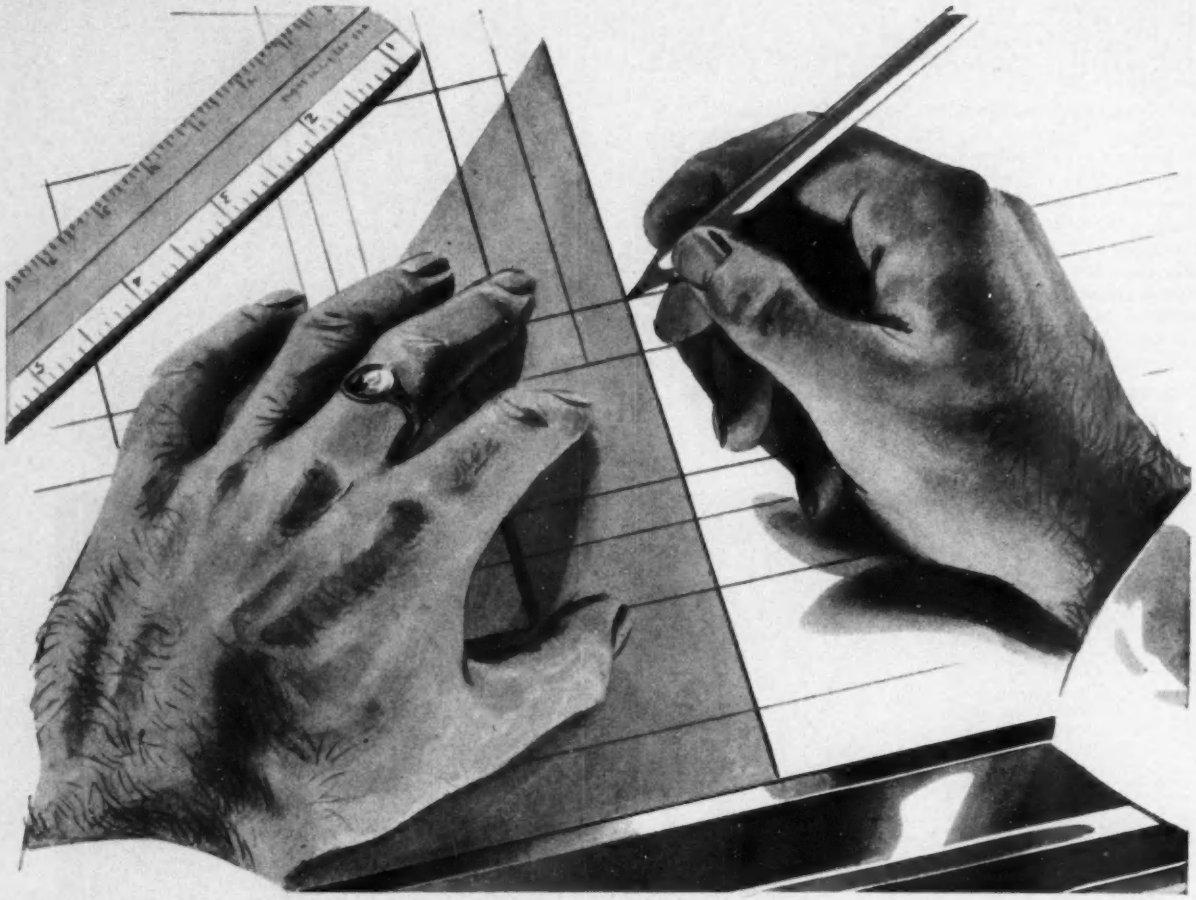

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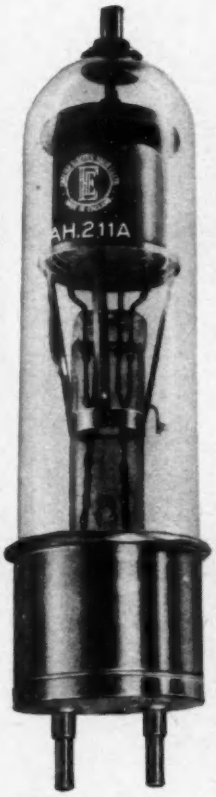

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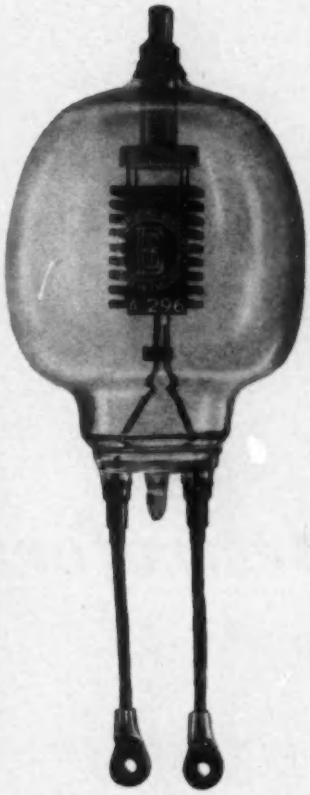

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HIGH VACUUM	*3B24W	3B24W	CV2858	20	0·3	0·06
	*A207	—	CV2160	45	1·1	0·35
	A235	2-25A	—	25	0·5	0·05
	*A237	—	CV482	65	1·5	0·25
	*A296	—	—	25	6·5	1·25
MERCURY VAPOUR	*869B	869B	—	20	10	2·5
	*872A	872A	CV1449 & CV642	10	5·0	1·25
	AH200	—	—	20	10	2·5
	*AH205/857B	857B	CV2673	22	40	10
	*AH211A	—	CV532	16	8·0	2·0
	AH213	—	CV2723	20	10	2·5
	*AH221	—	CV5 & CV1435	20	5·0	1·25
	*AH238	—	CV1629	13	5·0	1·25
XENON	†3B22	3B22	CV3815	0·725	‡4·0	‡0·5
	*3B28	3B28	CV1835	10	1·0	0·25
	*4B32	4B32	CV2518	10	5·0	1·25
	*AX228	—	CV2399	13	6·0	1·25

* Preferred Type. Recommended for new equipment. † Full wave rectifier. ‡ Per section.

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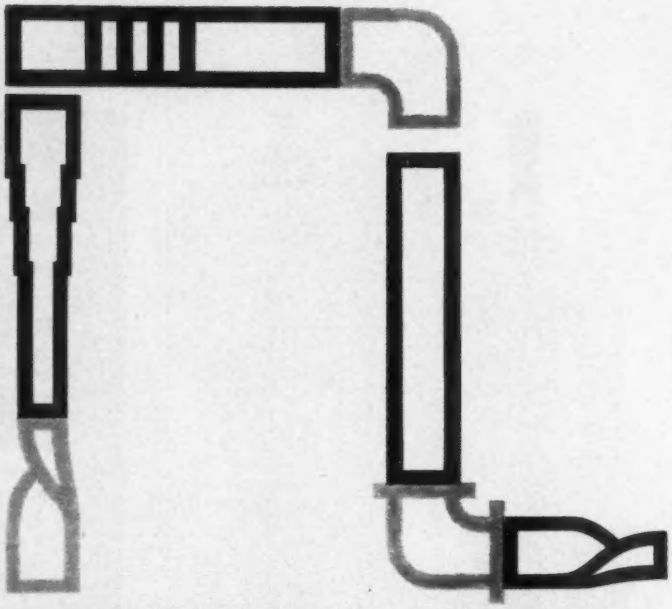

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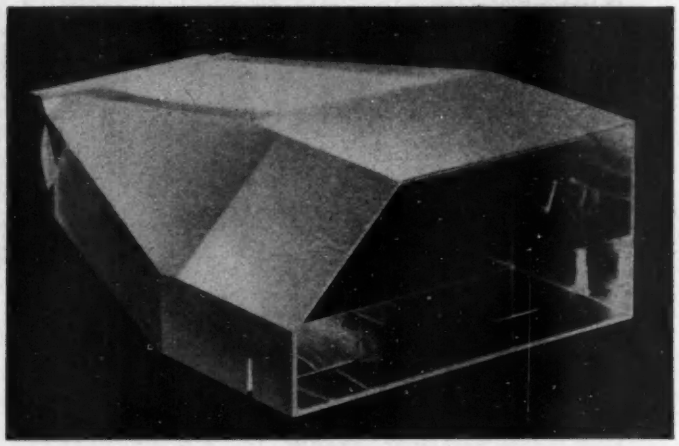

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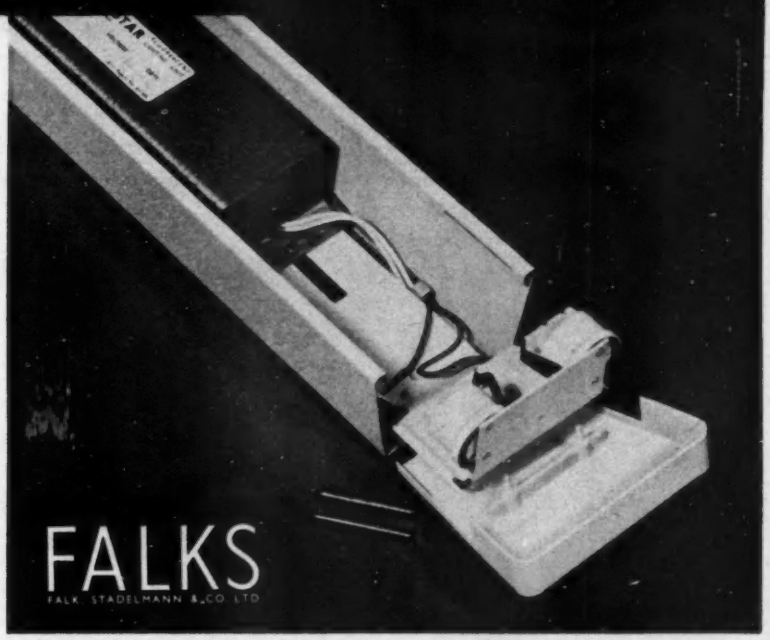

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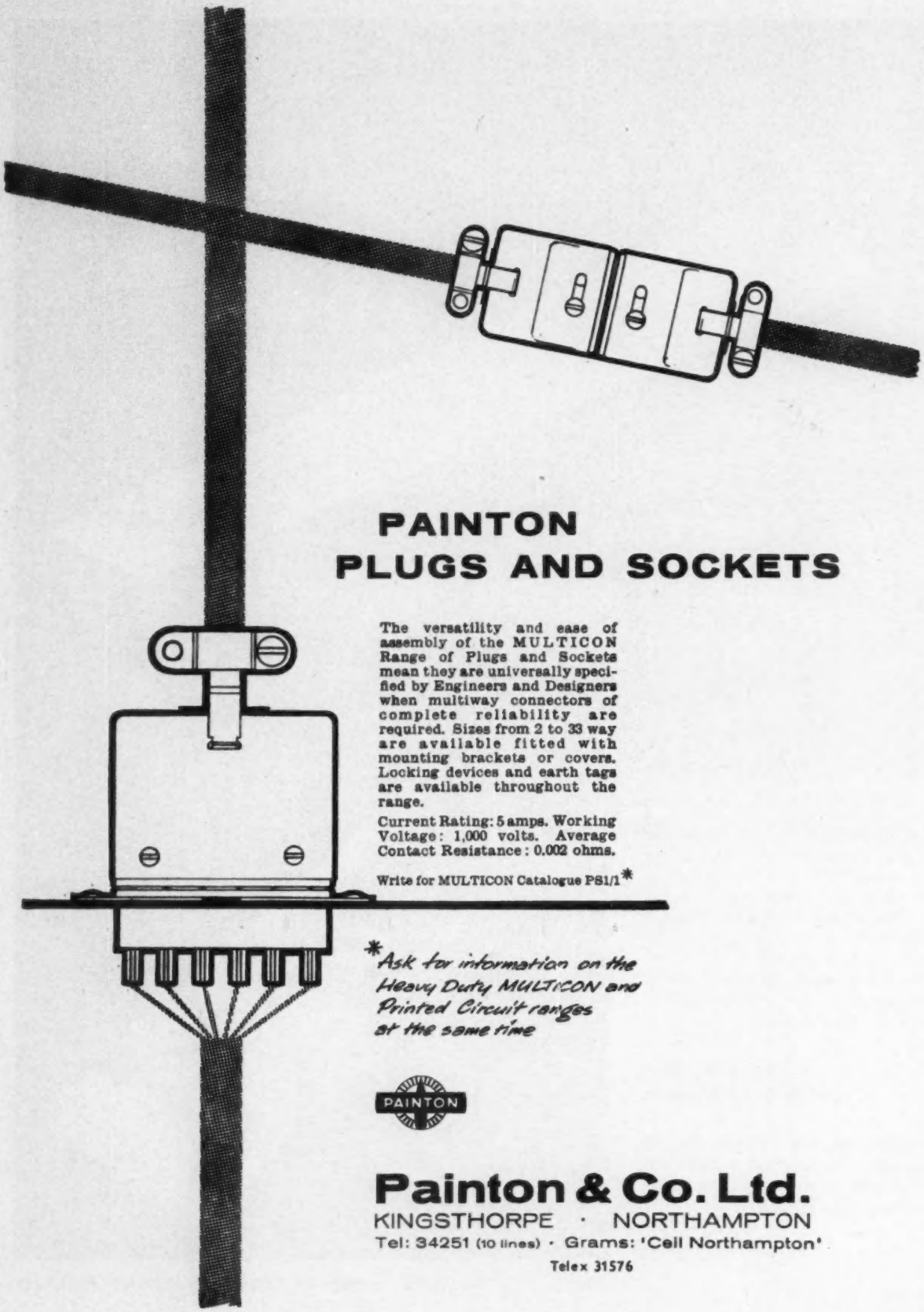

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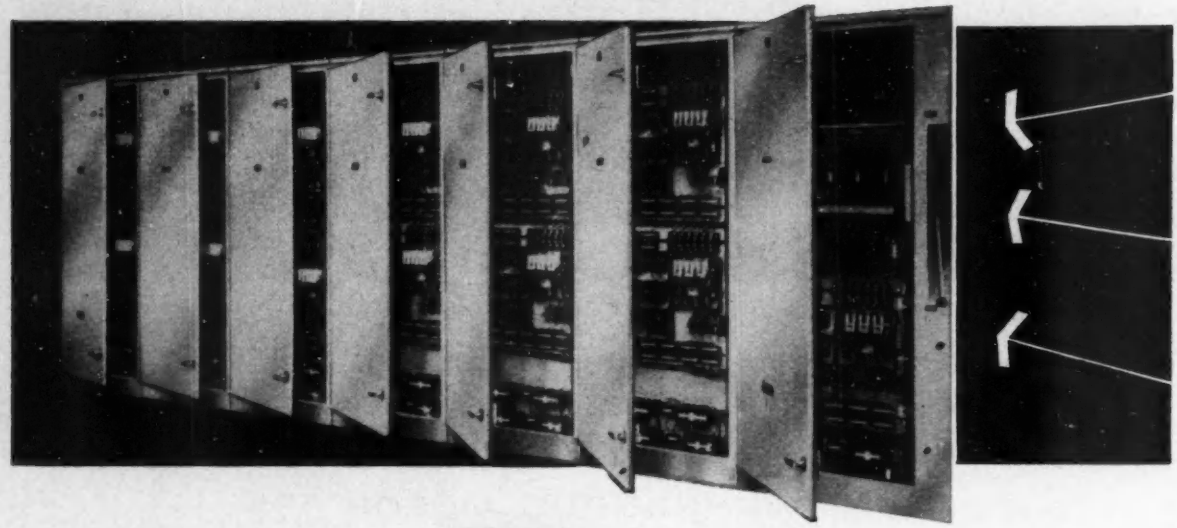

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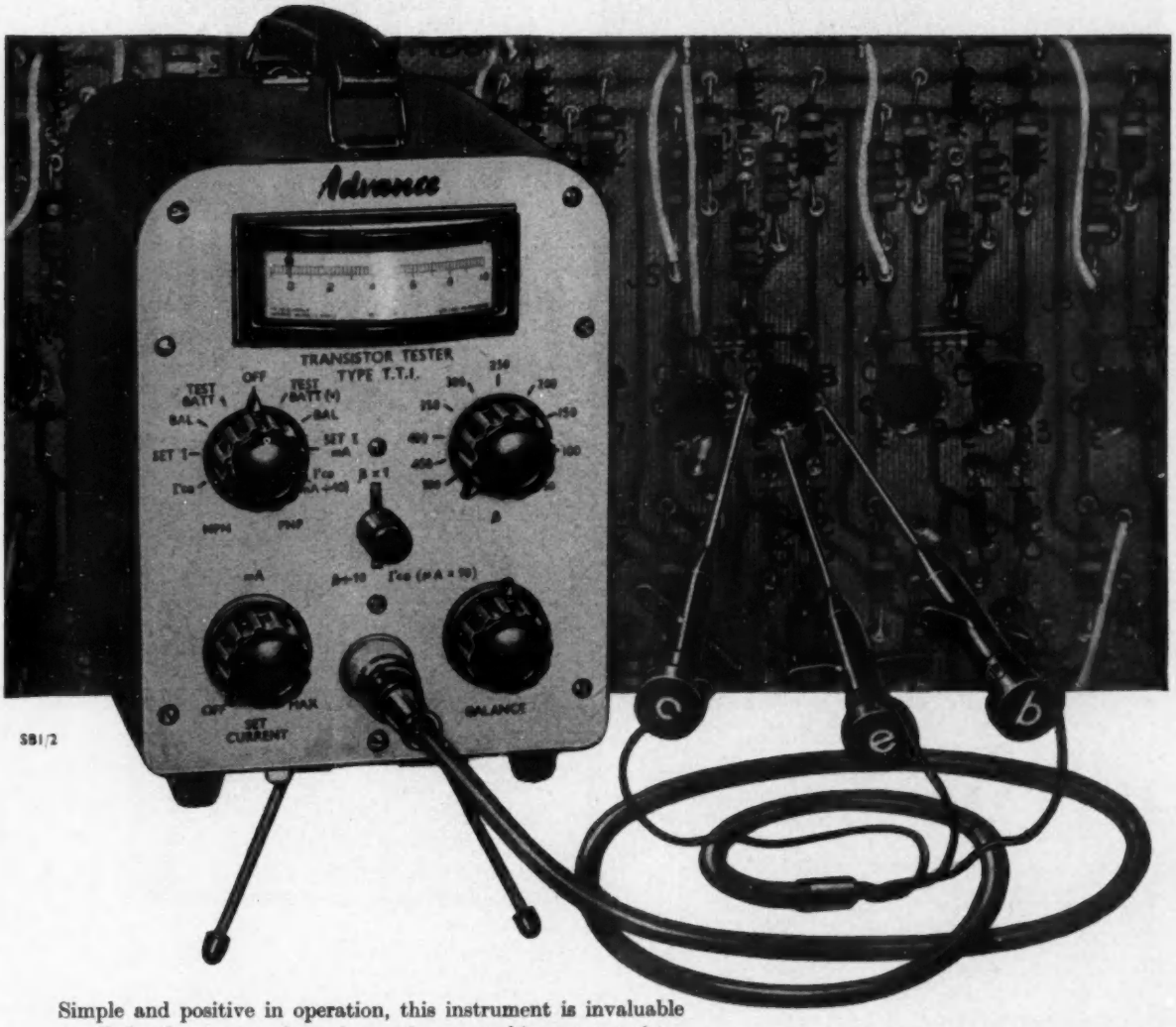

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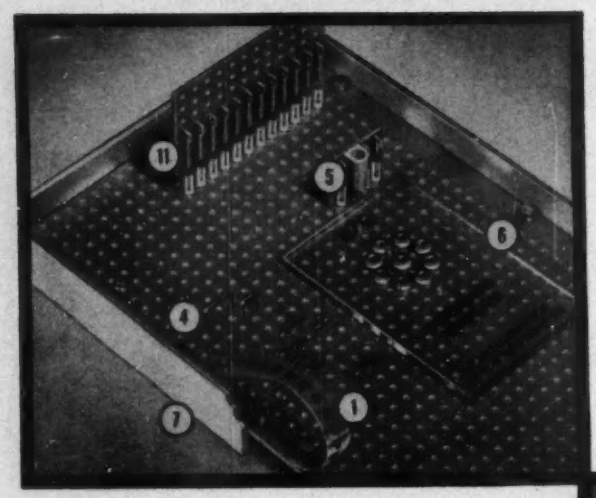
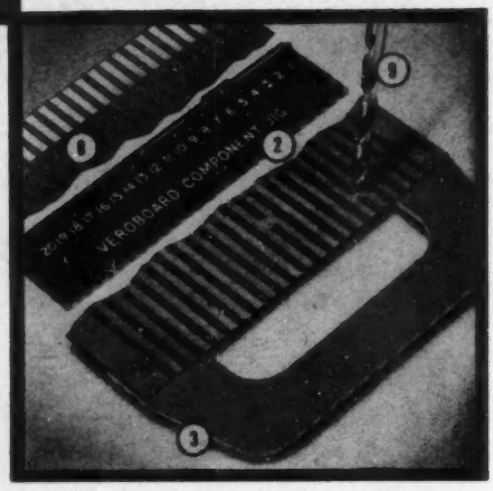


with **vero board accessories**



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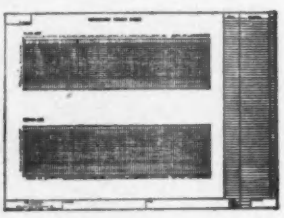

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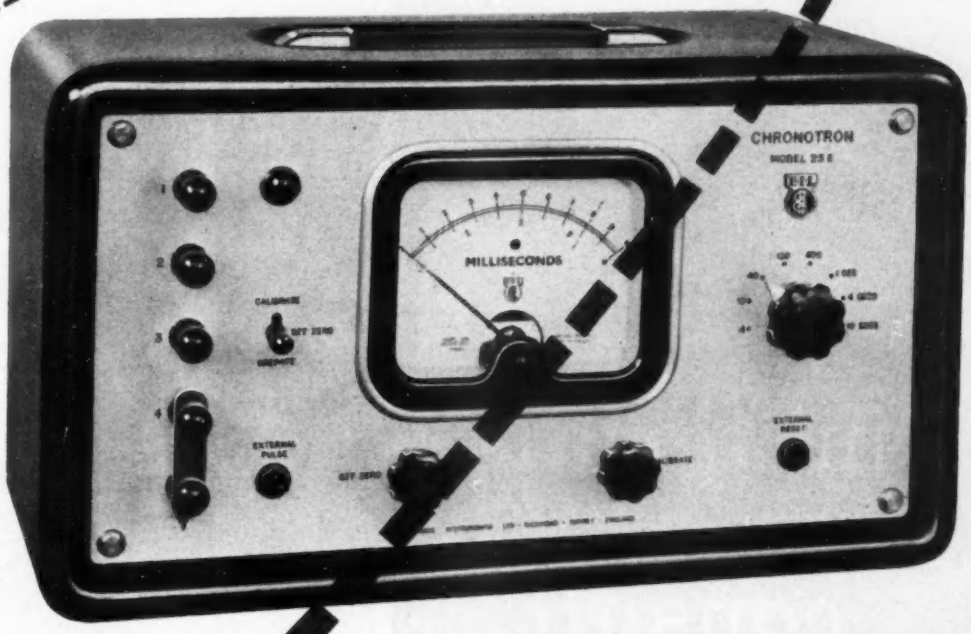
The Measure of TIME



The Chronotron
Model 25E Price £118

E·I·L

The Chronotron is the millisecond equivalent of the laboratory stopclock, covering time intervals from 0.2 milliseconds to 10 seconds in eight ranges. The accuracy of measurement lies between 1 and 2 per cent according to the range selected, and timing may be started and stopped by keys or contacts, by changes in applied d.c. voltages or by light beam interruption. Accessories for single or double pulse selection and a photocell camera timing unit are available for use with the Chronotron.

More than 1,500 Chronotron Millisecond Meters are in daily use in many countries for timing relays, fuses, contact breakers, projectiles, vehicles, camera shutters and human reaction times. For most millisecond timing applications the Chronotron will do the work of instruments costing three times the price.

E·I·L

ELECTRONIC INSTRUMENTS LIMITED

RICHMOND · SURREY · ENGLAND · RIChmond 5656

EE 36 038 *for further details*

Before specifying magnetic materials consult this record

HIGHEST μ OBTAINABLE
... is in nickel-iron alloys—available in all forms down to ultra-thin strip.

SQUARE HYSTERESIS LOOP
... nickel-iron alloys are the best materials for magnetic amplifiers and saturable reactors.

LOW CURIE POINT
associated with certain nickel alloys provides a temperature dependent permeability—a valuable characteristic for compensating and control devices.

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Nickel and nickel alloys make the most rugged and efficient transducers for ultrasonic equipment.

HIGH B.H. MAX
Nickel-cobalt-aluminium-iron permanent magnets provide the maximum energy per unit volume, extreme stability and the greatest resistance to the effects of temperature change and vibration.

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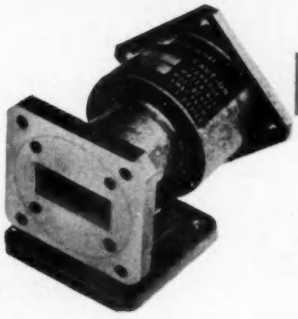
EE 36 039 *for further details*

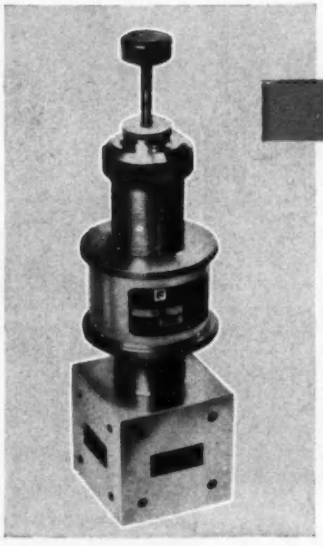
FERRANTI

Ferrite Circulators



X-BAND 3-PORT FERRITE CIRULATORS TYPES 5M/16.1 AND 5M/16.2A

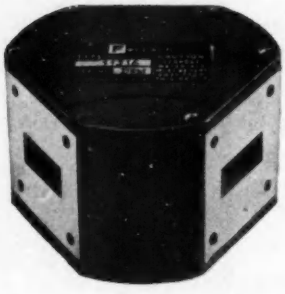
	5M/16·1	5M/16·2A
Bandwidth	9375 ± 100 Mc/s	8800 ± 30 Mc/s
Temperature Range	—40 to + 80°C	—40 to +80°C
Power Rating	50kW peak 50 W mean	50 kW peak 50 W mean
Weight	12 oz	6·5 oz



TUNABLE 4-PORT FERRITE CIRCULATORS SERIES 10A

Tuning Range.....8000—9600 Mc/s
Power .....200 W
Weight.....4½ lb

Performance at Centre Frequency	Performance for a bandwith of ± 30 Mc/s
Isolation..... > 30 db	Isolation.....> 15 db
Insertion loss <·3 db	Loss..... < 0·4 db
V.S.W.R..... < 1·25	V.S.W.R..... < 1·25



3-PORT FERRITE CIRCULATORS SERIES 11M

Frequency .....Centred in the band 8000-11000 Mc/s

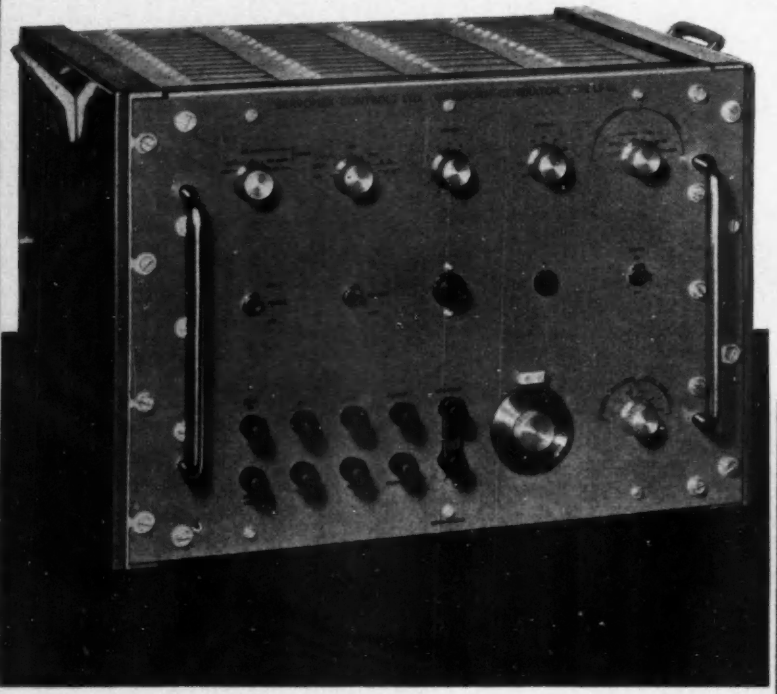
Bandwidth	Loss	Isolation	V.S.W.R.
	0·10 db	> 35 db	1·05
100 Mc/s	0·15 db	30 db	1·08
200 Mc/s	0·20 db	25 db	1·12
400 Mc/s	0·25 db	20 db	1·20

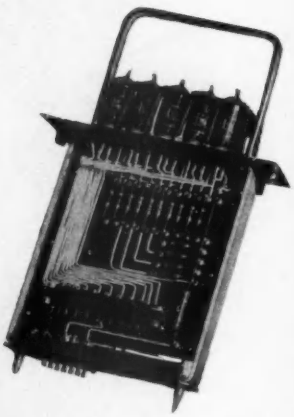
Max. Power .....50 kW. Peak
1kW. Mean
Weight.....1½ lb approx.

FERRANTI
First into the Future

Write for further details to:
FERRANTI LTD · KING'S CROSS ROAD · DUNDEE
Tel: DUNDEE 87141
DS/T 72

the most flexible supply of test signals for testing servo mechanisms

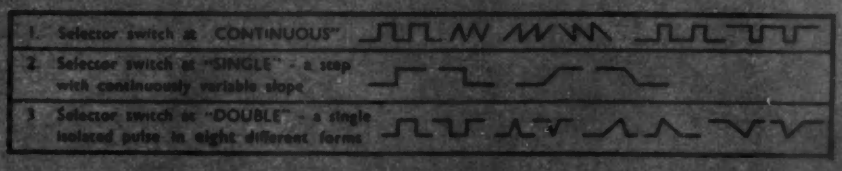




This unique instrument is being used by discriminating control engineers all over the world for measuring the dynamic response of automatic control systems.

With it, one can carry out measurements of the frequency response to sinusoidal input; the step-function response; the response to ramp functions; the response to sine-squared pulses; and many other special tests.

- ★ *Sine waves from 500 cycles/sec. down to one cycle every 2,000 secs. (33 minutes).*
- ★ *Pulses and square waves with rise time less than 10 microseconds.*
- ★ *Ramp functions with a linear rise variable from 1 millisecond to 1,000 seconds.*
- ★ *Over 30 different waveforms available.*
- ★ *Voltage variable between 100 microvolts and 150 volts peak-peak.*
- ★ *Load current up to 5 milliamps peak.*


1. Selector switch at "CONTINUOUS"
2. Selector switch at "SINGLE" - a step with continuously variable slope
3. Selector switch at "DOUBLE" - a single isolated pulse in eight different forms

THE PROBLEM...

To measure the frequency response of a massive servo control with cut off frequency around one cycle in five minutes, and with an output amplitude of ±20°.

a possible solution,

Set up a conventional sinewave generator running at a frequency substantially lower than the expected cut off, and adjust the amplitude to give peaks of ±20° at the servo output.

DIFFICULTY 1: *Assuming that a suitable generator exists, each change of amplitude will require about an hour to allow the system to settle and take a reading at the next peak. Thus, proceeding this way, several hours will be wasted before tests can start.*

DIFFICULTY 2: *If it is required to make transient tests, the experimental arrangement will have to be upset and new equipment brought up.*

the Servomex solution,

Use the LF.51 set to SINGLE SHOT and SQUARE WAVE. Turn the amplitude up to give exactly 20° displacement of the servo output. Switch to CONTINUOUS and SINE WAVE and start making measurements. Total time wasted: less than ten minutes. Furthermore, transient tests using virtually any wave form you may require can be carried out at the flick of a switch and without any further delay.

This "problem" stresses two practical advantages of the LF.51 — the single shot facility for setting the amplitude, and the fact that the upper and lower limits of the output voltage are identical whatever wave form is used. These are practical advantages arising from the fact that the LF.51 was designed by servo engineers. There are many other practical advantages of the instrument which will appeal to you if you are a servo engineer, or otherwise engaged on measuring the dynamic response of low frequency systems, and if you would like a demonstration and test under practical working conditions, *you are invited to write or telephone for an appointment.*

SERVOMEX

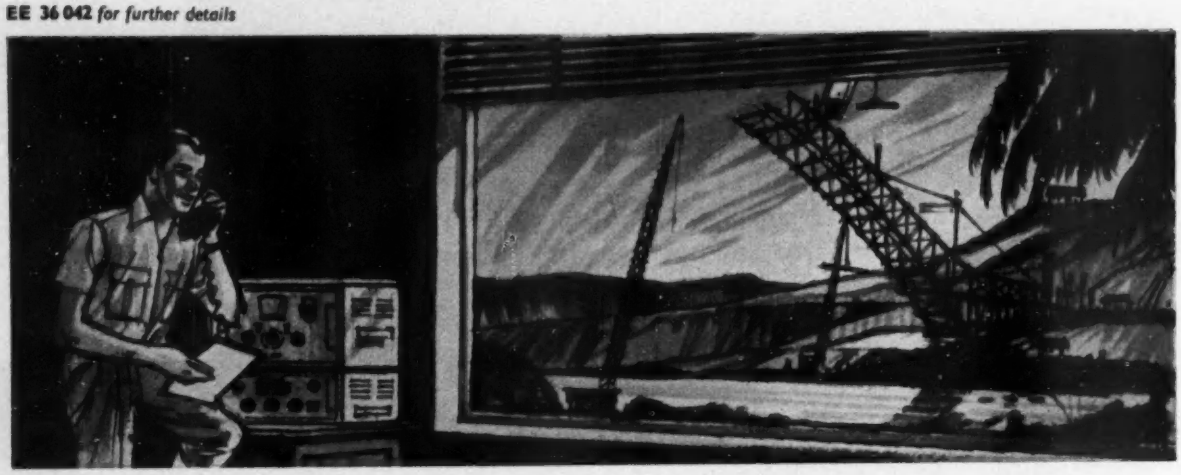
Servomex Controls Ltd Crowborough Sussex
Crowborough 1247

LF.51

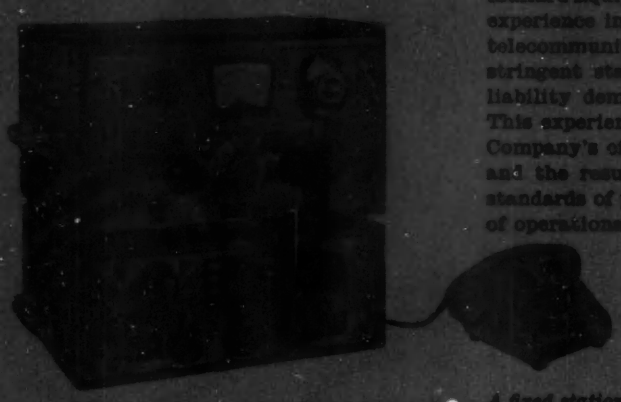
low frequency wave form generator

the World's best!

EE 36 042 *for further details*



A COMPLETE RANGE OF TELECOMMUNICATIONS EQUIPMENT FOR BOTH CIVIL AND MILITARY APPLICATIONS



Mullard Equipment Limited has had extensive experience in the design and manufacture of telecommunications equipment to meet the stringent standards of performance and reliability demanded by military authorities. This experience has also been applied to the Company's civil communications equipment, and the result is a range with the highest standards of performance to meet every kind of operational requirement.

SL57/68 HF Single Side-Band Transmitter/Receiver

- *A fixed station equipment providing both telephone and telegraph communications.*
- *Power output of 100 Watts, giving medium range coverage at 2-18 Mc/s.*
- *Transmitter and receiver are entirely separate and can be used either together or individually.*
- *Facilities for simplex and duplex working.*
- *Full remote control facilities including channel selection.*
- *Able to operate from either a.c. or d.c.*
- *Very high stability without a speech clarifier.*
- *Double Side-Band compatibility.*

Make contact with...

Dual Diversity Independent Side-Band Receiver GFR 552

Designed in conjunction with the British Post Office, the GFR552 is capable of receiving independent, single and double side-band transmissions over a continuously variable frequency range of 4-30 Mc/s in long distance HF radio links.

Automatic frequency control is incorporated and provision is made for 9 crystal channels and variable bandwidth facility.

The equipment is suitable for use in broadcast-relay applications and can be worked with dual and triple-diversity aerial systems.

Military VHF/FM Transistorised Receiver C45

In service with the UK Army and fully consistent with NATO standards, the C45 is hermetically sealed and ruggedised to K114.

It is designed for mobile working on 12 or 24V d.c., giving 15W output over the range 23-38 Mc/s, and is available for 100 Kc/s channel spacing (151 channels) or 50 Kc/s channel spacing (301 channels). Operation is very simple and no netting procedure is required. Facilities include; vehicle inter-communication through the harness and also re-broadcasting and remote control up to 1,000 yards on a single pair.

HF Command Transmitter SL56

This is a versatile equipment which can be employed in a variety of applications by the use of alternative drive units such as the C11 or SL63. It is continuously tunable over the range 2-24 Mc/s and, because of unit construction, it is suitable for installing in vehicles from the "Land Rover" upwards. With suitable drive units, the SL56 provides the following outputs:

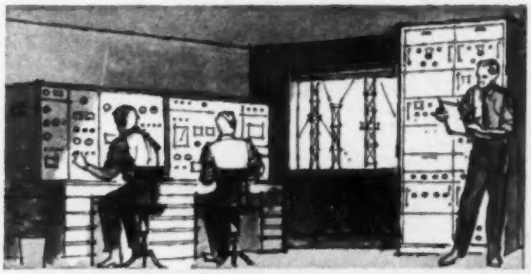
CW ... ... 1 kW FSK ... ... 1 kW

RT ... ... AM-400W, PM-1 kW, SSB-1 kW

The SL56 amplifier units can be supplied in instances where customers already have suitable drive units.

Rural Carrier Telephone System TRC7

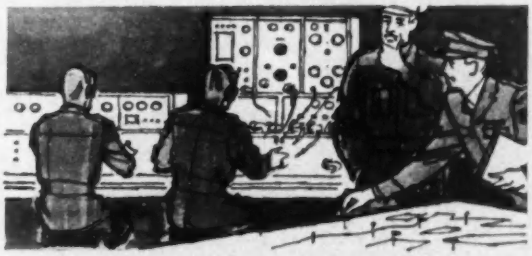
This transistorised carrier telephone gives up to 7 stackable channels; a separate frequency for each subscriber gives complete privacy on a single exchange pair. The flexibility of the system enables it to be arranged to suit almost any requirements of the user. It is simple to install, fully tropicalised and has a low power consumption. A.C. or d.c. power supply units are available, and the choice of relays sets is compatible with all standard exchange systems.

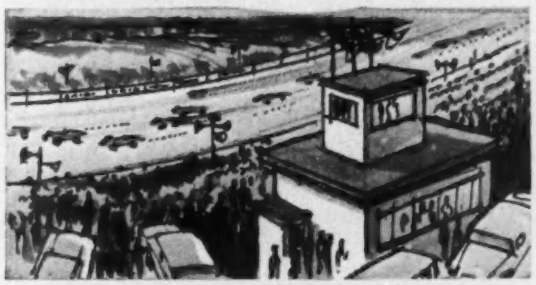


Low Power HF Single Side-Band Radio Telephone SL55

Compact single unit (including a power pack for 12/24V d.c. or 110/200V a.c.) for fixed or mobile working. The transistorised d.c. power pack gives a low consumption when used from batteries.

The SL55 has a frequency range of 2-16 Mc/s, and its frequency stability eliminates the need for a speech clarifier. Provision is made for 4 crystal channels. Remote control can be provided, and the set is also suitable for double side-band and CW telegraphy.





For details of the full range of telecommunications equipment, write to the following address quoting reference No. D 96/7/8

MULLARD EQUIPMENT LIMITED

Mullard House, Torrington Place, London W C 1
Telephone: Langham 6633

ME679

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NICKEL SILVER AND CUPRO-NICKEL

For Electronics, Radio & Telecommunication Fields . . . . . .

NICKEL SILVER — All qualities from 5% Nickel content to 30% Nickel content.

CUPRO-NICKEL — All qualities from 5% Nickel content to 45% Nickel content.

SHEET Maximum width 24". Minimum thickness 0·006".
STRIP Maximum width 18". Minimum width ½". Minimum thickness 0·005"
WIRE Maximum diameter ½". Minimum diameter 0·0025"

Specialities High finish Nickel-Silver Telephone Strip and Sheet conforming to BSS 1824, or to your own specifications for the manufacture of Spring contacts, Relay blades, etc.

We also specialise in producing Copper-Nickel Alloys (Cupro Nickel) with special resistance properties in the form of Sheet, Strip and Wire.

Established 1845

JONES & ROOKE (1948) LTD. NORTHWOOD STREET ROLLING MILLS. BIRMINGHAM 3.

BRANDS HATCH

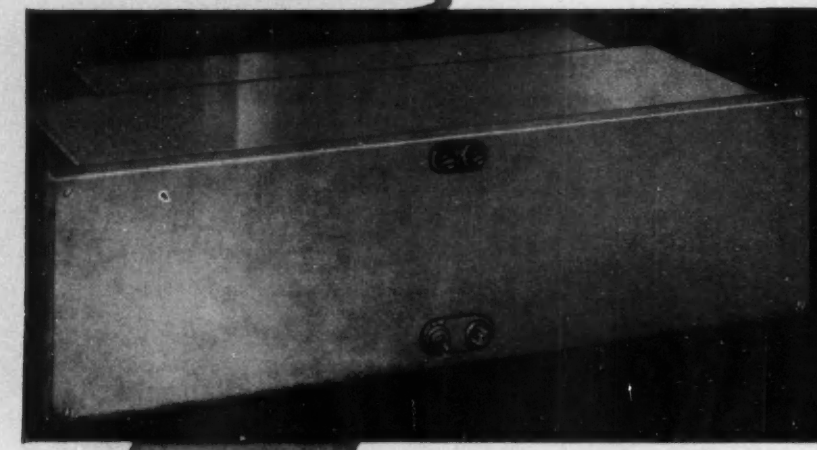
Both you and the racing driver would agree that all circuits have their own characteristics and problems . . . . .

but for *you*, when selecting a valve for all round optimum performance . . . . .
better make it BRIMAR

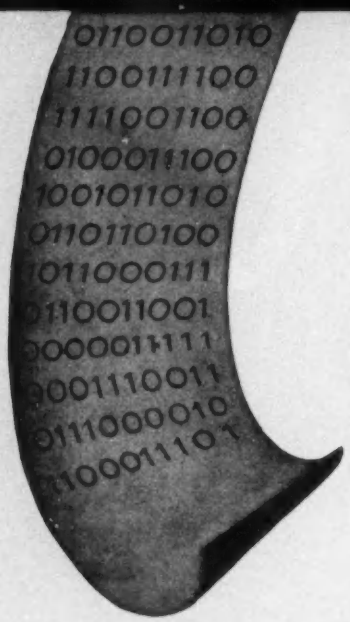
BRIMAR LIMITED FOOTSCRAY SIDCUP KENT FOOTSCRAY 3333 BVA

EE 36 045 *for further details*

From analogue input to digital output



in 1msec to 0·1% accuracy



with the transistorised CONVERTER L281

This equipment, a vital component for fast data logging systems, samples an input analogue voltage and gives a digital output available in parallel or serial form, in pure binary or binary coded decimal.

- **Sampling time less than 1 msec, with maximum sampling speed 1 kc/s.**
- **Accuracy to 0.1%.**
- **Pure binary or binary decimal conversion.**
- **Internal or external clock facilities.**
- **Compact construction, 5¼ in. in standard 19 in. rack.**
- **Fully transistorised.**

Please write or 'phone for further information on this outstanding equipment.

MULLARD EQUIPMENT LIMITED Mullard House · Torrington Place · London WC1 · Telephone: LANgham 6633

ME643

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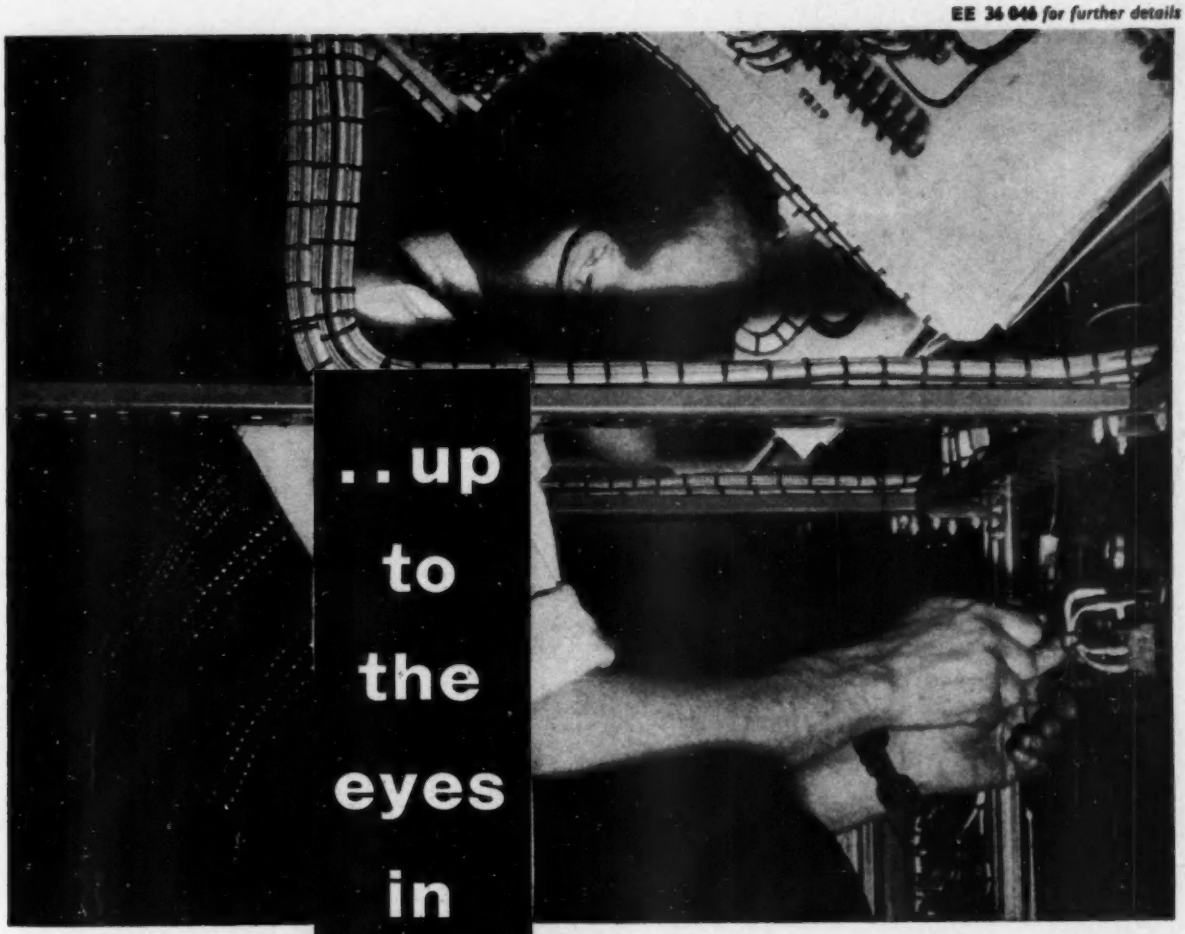

..up to the eyes in it!

Data amplifiers
Automatic typewriter system
Pressure & Load transducers
Torque Measurement
Electronic Design Service
Counter Timers

It takes a brilliant mind and an orderly one to design and develop new installations and electronic techniques appropriate to the problems of the 60's. The skilful manufacture to these designs by the craftsmen, using every type of aid, is equally important. Based on the experience of the Black Knight Research Vehicle Programme and a wide range of commercial contracts, the standard of neatness and finish, essential to long trouble-free life is a particular feature of Saunders-Roe electronic apparatus. If you have an engineering problem, we may be able to offer you a solution, based upon the latest electronics engineering techniques.

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A MEMBER OF THE WESTLAND GROUP OF COMPANIES

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A new tool for the semiconductor industry . . .

NEC'S INFRARED MICROSCOPE

There has been no device for viewing stress and impurities in silicon crystals. Now NEC's development of the infrared microscope effectively fills this need.

The microscope uses an NEC image tube rated at 1.3 microns, the most sensitive commercially available. When using the 40x objective and 15x ocular lenses, IR magnification is 1,080x.

Solid state applications are inspection of silicon crystals and other intermetalic compounds for stress and impurities. Other applications are in biological and medical research.

INFRONICS at NEC

Since 1954, NEC has been concentrating on industrial applications of infrared energy and is among the leading producers of devices utilizing infrared. In addition to the microscope these include optical pyrometers, night viewers, and a pupiloscope. This year NEC will demonstrate developments in IR communications.

PERFORMANCE

Electrical
Input voltage : 100-115 v. 50 or 60 c/s
Power consumption : 70 watts

Optics
Visible image : 20x to 1,500x
IR image : Naked eye 40x to 1,080x
Photographic film: 4.3x to 120x

Wavelengths
Visible : 0.4 μ to 0.76 μ
IR : 0.76 μ to 1.3 μ (with filter)

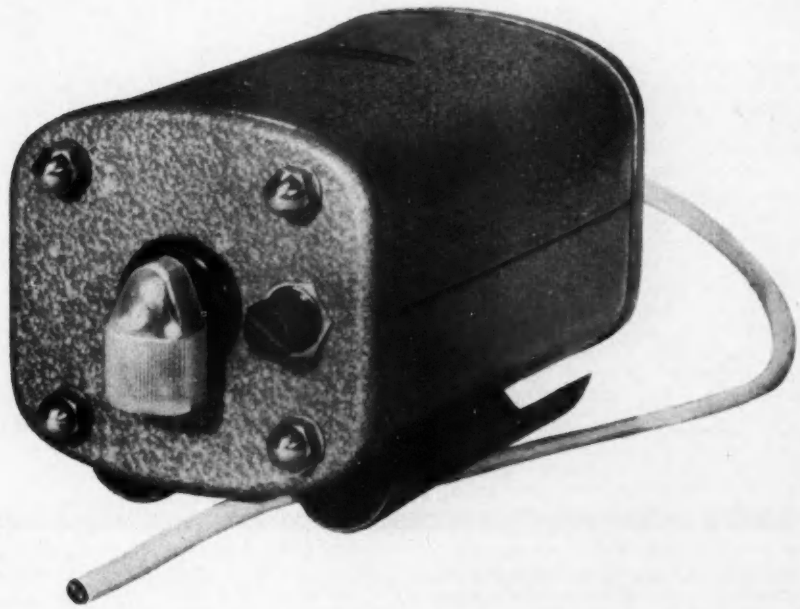
Dimensions (mm.)
Width length height
700 x 180 x 400
Weight : 23 kg

NEC *Nippon Electric Company Limited.*

Systems / Components

P.O. Box 1, Takanawa, Tokyo, Japan.

A new inexpensive, portable and attractive range of Auto, isolating and low voltage transformers for domestic or single-unit industrial use. Standard models are available for 230-250 v. input and 240, 110, 24 and 12 v. output (other voltages can be made to order).



Gardners

CASTLE SERIES

TRANSFORMERS

22 standard double wound ratings and 9 auto wound are now listed, with dimensions, weights and prices in Gardners Industrial and 'SM' (Private users) Catalogues. Existing registered holders of the Industrial Catalogue have been supplied with Amendment Sheets covering the new Castle Series.

GARDNERS RADIO LTD., SOMERFORD, CHRISTCHURCH, HANTS. Tel.: CHRISTCHURCH 1734

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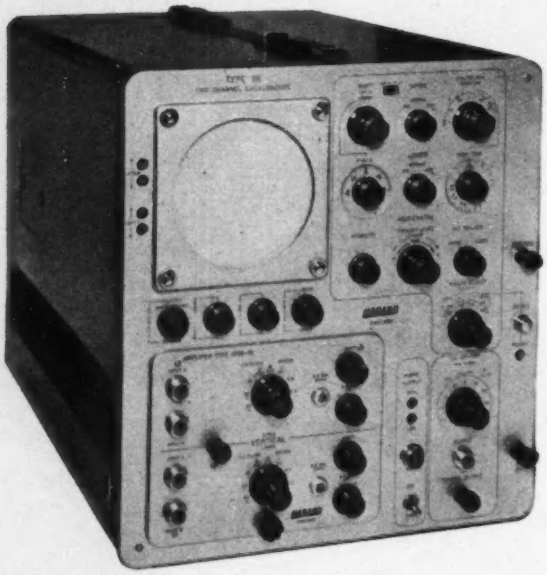
a new
high sensitivity
two channel oscilloscope

MODEL **311**



For research needing the display and measurement of low level signals. Maximum sensitivity 100μV/cm response d.c. to 150 Kc/s.

Calibrated and highly stable Y amplifier gains.
Wide range Time Base directly calibrated in time/cm from 12.5 sec to 1 μsec/cm (2% accuracy) continuously variable.
Independent or common X shifts in two channels, one being calibrated in degrees for phase displacement measurement.
X-Y displays on one channel from the two Y amplifiers.

Plug-in pre-amplifiers

of various characteristics may be inserted, one of which provides a maximum sensitivity of 100μV/cm and includes differential inputs with 10 megohms impedance and good discrimination.
Highly stabilised against mains variations.
Square wave calibrator incorporated, enabling Y amplifier gains to be set up accurately for voltage measurement within 3%.

This instrument represents a major advance in the design of highly sensitive d.c. two channel oscilloscopes, derived from years of experience in this specialised field.

Ideal for electrophysiological work, but with a versatility such that many problems in physics, chemistry, and mechanical vibration or servo systems can be effectively dealt with.

NAGARD LTD

18 AVENUE ROAD . BELMONT . SURREY . TEL: VIGilant 9161/2/3

A WORLD OF VIBRATION

Vibration technology is a comparatively new development in the field of environmental engineering. Its applications in measuring metallurgical stresses and strains, in simulating fatigue to destruction point, are fairly well-known, but even the present scope is far wider than these. The potential is immense to a degree which possibly outreaches that of any other applied science. It is even possible that there is much to be rediscovered, for the histories and mythologies of ancient civilizations abound in references to physical motion achieved through sound vibrations. The destruction of the walls of Jericho is an example; and it has been suggested that the Pyramids' vast masonry was elevated by similar means. But fascinating and perhaps revealing as that line of inquiry may be, this report will deal principally with the immediately practical uses of vibration testing.

From eyes to motor cars is an apt and related part of the applications range. Taking the first and uncomfortably picturesque example, an incidence of severe headaches and impaired vision suffered by transport drivers led to tests with vibration equipment. These showed that through vibration on certain road surfaces, the drivers' eyes were being literally bounced back and forth in their sockets.

MOTOR VEHICLE INDUSTRY

Car bodies and their attachments are subject to mechanical and other vibrations transmitted through suspension systems. What with wear and tear and varying concern for maintenance, the noises which can result are an age-old problem at the service station. The drumming heard by the owner 'under the back seat somewhere' is usually non-existent in normal workshop testing; out on the road it's audible but locating it is a tedious and uneconomic guessing game.

Yet further complications arise out of the fact that the vibration source may be far removed from the apparently offending component or structure.

We have a compact generator/oscillator/power amplifier combination by which all the running vibrations can be simulated *in the workshop* and the noise source accurately and quickly located. Similar equipment is used by car manufacturers so that vibrations can be compensated or designed out.

ROAD CONSTRUCTION

Roads, too, can be investigated with vibration equipment. An applied vibration is picked up at a distance, on an oscilloscope. The signal time and strength factors vary according to the nature and thickness of the surface and subgrade materials. By these readings it can be determined whether or not the construction is according to specification. Periodic tests will reveal the extent of any deterioration. In research, the behaviour of roads under various traffic conditions can be established and the information used in framing specifications for new roadworks.

AIRCRAFT INDUSTRY

In the aircraft industry, vibration testing has long been a vitally important technique. Bearing in mind the possible outcome of the failure of quite small components, vibration problems in land vehicles and structures pale into comparative insignificance. Goodmans equipment is widely used to test dynamic models . . . even whole aircraft . . . and on the multiplicity of instruments and electronic apparatus.

The tremendous power and complexity of rocket-propelled vehicles set still more-exacting requirements and for these Goodmans are producing special generators.

OTHER APPLICATIONS

The miscellany of these is far too extensive to catalogue here, but the following will serve to demonstrate the scope.

In fatigue testing, vibration generators provide wide range and prolonged consistency.

Chemical and bio-chemical research are served by our smallest generator, the V47, in mixing, emulsifying and the measurement of interface potentials. It has been used also to simulate nerve signals and to assess vibration effect on living tissue. Experiments show that physical vibration and 'white noise' have anaesthetic properties.

Vibration equipment is used in the rubber, plastic and textile industries, as an aid in establishing the materials' mechanical properties.

Experiments in the machine tool industry have shown that small and carefully controlled vibrations can, in fact, improve stock removal, surface finish and minimize the effect of certain operations upon molecular structure.

This is inherently a world of movement. Everything vibrates within itself and often as an entity. These forces can be observed, reproduced, supplemented. There must therefore be many functions for our vibration equipment which even we can only guess at . . . and even more as yet unthought of. Name your problem; consider what may be done better, faster, more economically . . . what may be done perhaps for the first time, with the help of vibration equipment. It's more than likely that the means to the end is ready-made.

Goodmans electro-mechanical vibration generators, the largest range in Europe, comprise:

TYPE	PEAK THRUST
V47	2 lb
390A	17 lb
790	35 lb
8/600 Mk.II	300 lb
VG108 Mk.II	5,300 lb
VG109 Mk.III	18,000 lb

There is available a corresponding range of oscillators and power amplifiers

GOODMANS
the vibration specialists

GOODMANS INDUSTRIES LTD. AXIOM WORKS, WEMBLEY, MIDDLESEX ENGLAND Wembley 1200 (8 lines) Cables: Goodaxiom, Wembley, England

Accredited Agents: HAWNT & CO. BIRMINGHAM · FARNELL INSTRUMENTS LTD. WETHERBY YORKS · A. R. BOLTON & CO. LTD. EDINBURGH

GD659

EE 36 051 *for further details*

BACKLASH ELIMINATED
PRECISE RESETABILITY
LAW ACCURACY ± 1.0% (ABSOLUTE)
or 0.25% IF REQUIRED

This ⅜" diameter Helical of high quality yet inexpensive has been designed for manual operation and is available in two versions

1. **For standard wiring**
2. **For PRINTED CIRCUIT application using the accepted 0.1" grid.**

HELICALS BY RELIANCE

10-TURN MINIATURE

TYPE HEL 07-10

SPECIFICATION

Resistance Range	**100-30,000 ohms**
Resistance Tolerance	**±5%**
Law Accuracy (Absolute)	**±1.0% or better to within 0.25% if required**

Independent Law Accuracy to closer limits

Rotation—effective angle 3600° +10° −0°

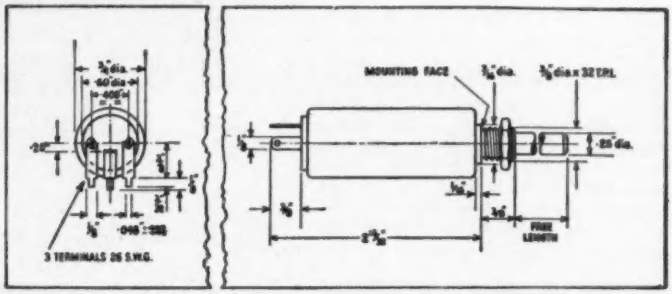
Dials available if required

Send for Data Sheets 11 and 12 which give full technical details and dimensions

For SERVO application an entirely new Low Inertia multi-turn Syncro size unit is available

See below ★

DIMENSION DRAWINGS OF PRINTED CIRCUIT & STANDARD VERSIONS HEL 07-PC10 & HEL 07-10



★ FOR RESEARCH AND DEVELOPMENT ENGINEERS

concerned with servo systems, function generation and environmental simulation, Reliance by means of an entirely new technique (covered by world wide patents) have developed and offer a multi-turn Potentiometer embodying in a single unit the following outstanding advantages:

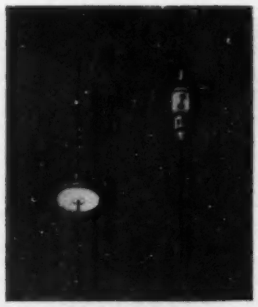
Size 11 Syncro Mounting
Low Torque <6 gm. cm
Low Inertia <0.01 gm. cm²
High Resolution
Multi Tapping Facilities
Multi Ganging

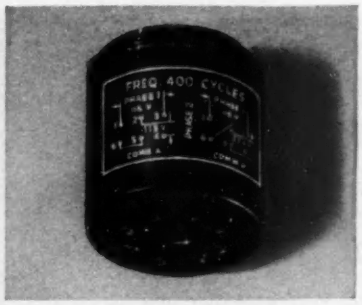
RELIANCE

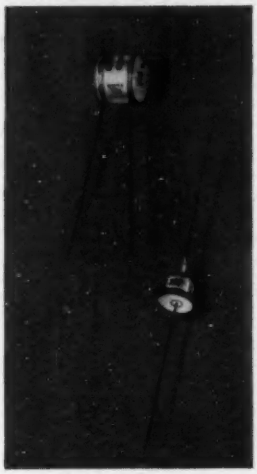
RELIANCE MANUFACTURING COMPANY (Southwark) LIMITED

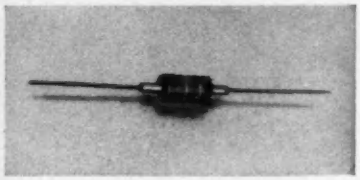
GD 767

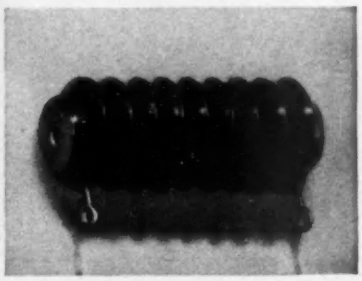
Sutherland Road, Higham Hill, Walthamstow, London, E.17. ***Tel: Larkswood 1118/9***











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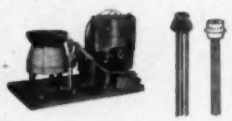
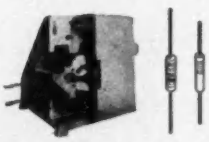
Model 148A — Completely Automatic Marking of all types of surfaces — flat, curved, corrugated, irregular, etc. — without hand rolling or pressing. May be mounted for automatic in-line marking or objects may be hand fed to adjustable work table. Average production 2100 to 3100 per hour.

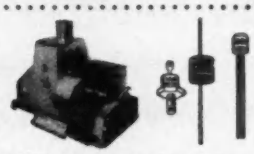
Model 122A — Simultaneous Top and Side Marking as well as date coding of transistors, similar cylindrical components with base leads. Hopper-fed machine automatically prints and ejects up to 2500 units per hour.



Model 69A — High Speed Color Banding of diodes, resistors, capacitors, similar axial lead cylindrical components. Up to 6 colors simultaneously, or 5 color bands plus typographical marking. Color, band width, spacing easily changed.



Model PAF-AG — Versatility for marking components with axial, one-end axial and radial leads, and components without leads. Production to 3000 per hour. Offset printing unit eliminates rubber plates, and use of Masterplates permits quick changes of all or part of the imprint.



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C3	5.4	197	.63
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Specials?

A916

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Housings of all sizes or shapes, simple or complex, made quickly and economically. The Imlok system of interlocking alloy extrusions and connectors includes many different angles, various special strengthening members and a host of accessories to give you a truly versatile method of construction.
Ideal for both prototype and production work Imlok can be bought in 6 different stages of manufacture.
1. Individual corner connectors with extrusions in 12 foot lengths.
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3. Pre-drilled connectors with extrusions custom cut by Imhofs to your lengths and mitred.
4. Framework assembled complete ready for fitting your own panels.
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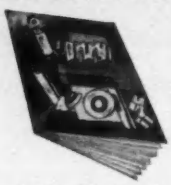
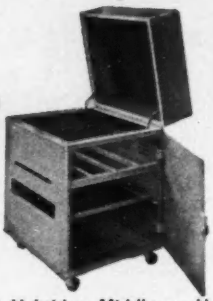
Whichever way you buy Imlok you will reduce general costs, cut out tool costs and be certain of having exactly what you require—quickly.

A917

A918

The Imlok Manual gives full details, illustrations and specifications of all components, step-by-step instructions as to their use, and suggestions on the various forms of unit which can be built with Imlok. Write today for your free copy!





A919

A920

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Holland: J. Th. van Reijsen, Delft
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Morocco: E.G.E.E., Paris (19).
New Zealand: Imarex (1960) Ltd. Auckland C3
Norway: Birger Christensen, Oslo
Portugal: Projectos e Construções Lda, Lisbon
South Africa: Switchcraft (Pty) Limited, Johannesburg
Sweden: Electronlund AB, Malmo 1
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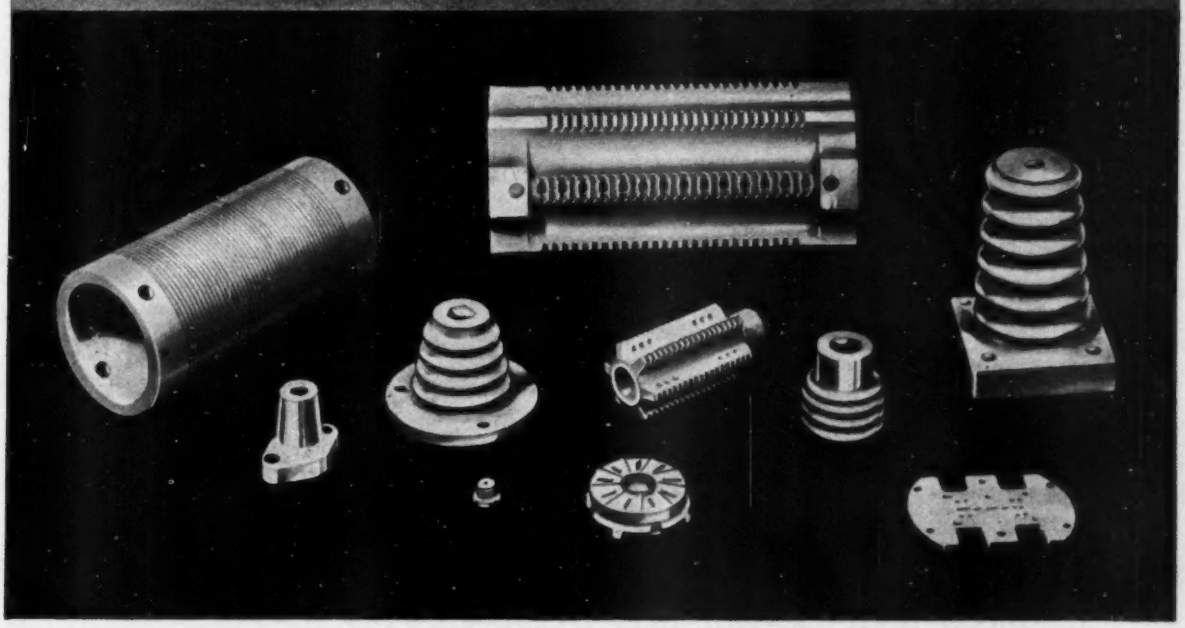
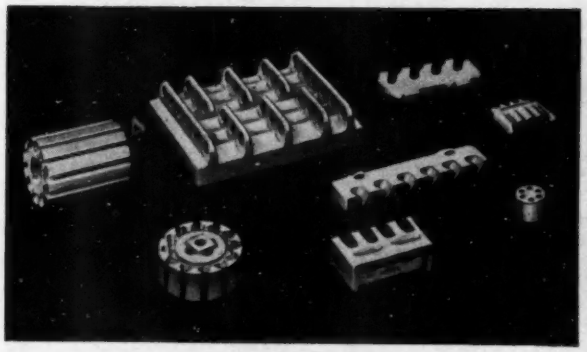
Bullers CERAMICS

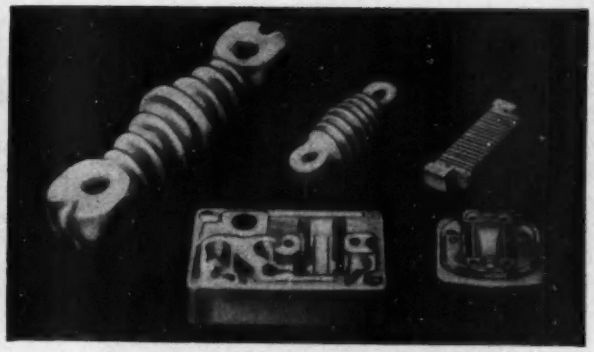
for the **ELECTRONIC INDUSTRY** (and Electrical Appliance Manufacture)



Frequelex—for high frequency insulation.



Refractories for high-temperature insulation.



Bullers porcelain for general insulation purposes.

Meticulous care in manufacture, high quality material, with particular attention applied to *dimensional precision and accuracy*, explain the efficiency and ease of assembly when using Bullers die pressed products.

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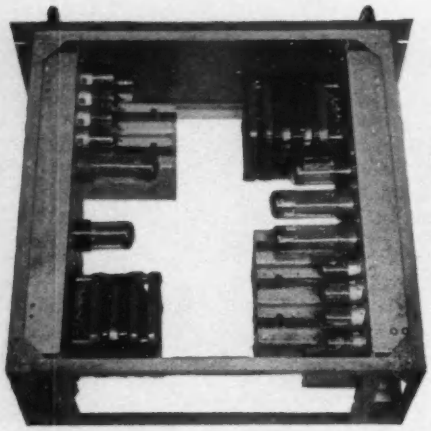
regulated - well ventilated - power supplies



Improved Brandenburg design, with wide centre ventilation and easier access to all components. Two of model V300/200 mounted in one suitable frame measuring 17½" × 17½" × 7". This shows one of many methods of mounting these units

All models voltage stabilized.

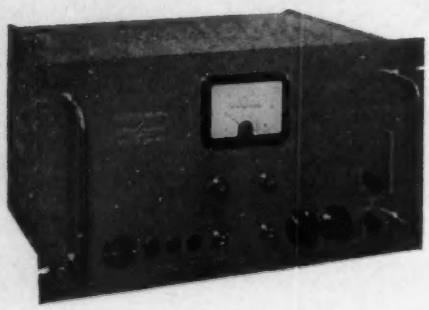
polarity reversible
effective resistance 0·1 ohm
stability 0.02% against ±10% mains change
ripple less than 2 mV
input 200/250 volts, 50 cycles.
output a.c. 100 and 200 mA models: 4×6·3V, 1·5A. 350 and 500 mA models: 2×6·3V, 5A. All can be paralleled
dimensions 100 and 200 mA models: 15½" × 5½" × 6½" high. 350 mA models: 15½" × 7½" × 7½" high. 500 mA models: two chassis, each 15½" × 5½" × 6½" high. Flanged open chassis, with frames available for converting all models to front panel mounting

All prices quoted are ex-works

200-350 V.		200-350 V.	
100 m/A.	£37 10 0	1 Amp.	£140 0 0
200 m/A.	£48 10 0	2 Amp.	£230 0 0
350 m/A.	£64 0 0	complete with 19" front panel and assembly	
500 m/A.	£80 0 0		

Models below 200 volts can be supplied to order.

new current-stabilized models



type C300
output current 50-300 m/A, continuously variable
output voltage 500 volts, maximum

type C400
output current 50-400 m/A, continuously variable
output voltage 600 volts, maximum

both models
input 200/250 volts, 50 cycles
stability better than 0.1% for 10% mains change
drift less than 5% for 30 minutes

C300 **£145** *C400* **£185** *both ex-works*

enquiries are invited for similar specifications

Brochure of Brandenburg voltage-stabilized range also available

BRANDENBURG LIMITED

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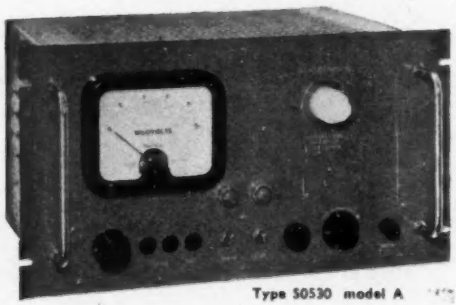
high voltage regulated power supplies —standard models up to 100 kV.

5, 10, 20 and 30 kilovolt regulated supply



Type S0530 model A

Type S0530

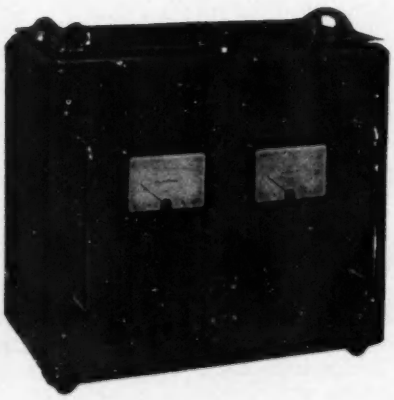
output	1 to 10 kV at 2 mA. Model A 2 to 20 kV at 1 mA. Model B 3 to 30 kV at ⅔ mA. Model C 500 V to 5 kV at 2 mA. Model D
input	200/250 volts, 50 cycles
polarity	positive or negative grounded available
regulation	better than 0.5% against full load
stability	better than 1% against ±10% mains change

- 5" Ernest Turner movement
- current metering jack
- standard 19" x 10½" P.O. panel
- for rack mounting or bench use

£135 ex-works

Models A, B and C can be supplied with reversible output polarity at £165

50 kilovolt regulated supply



Type MR50R

Type MR50R

output	5 kV to 50 kV at 1 mA
input	200/250 volts
polarity	reversible
regulation	0.5% against full load
stability	0.5% against ±10% mains change
dimensions	W: 24" H:23" D: 15"

£245 ex-works

100 kilovolt regulated power supply

Type MR100R

output voltage	10 to 100 kV, continuously variable at 1 m/A max.
polarity	reversible
ripple	0.1%
regulation	better than 1% no load to full load
stability	better than 1% against ±7% mains change
input	200/250 volts, 50 cycles
metering	output voltage and current metered
dimensions	W: 24" H: 44" D: 19"

£525 ex-works

Brochure on request For further specifications of this Brandenburg range of standard high voltage equipment, please write for brochure.

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NLS V44 DIGITAL VOLTMETER

Gives readings faster, more accurately, with greater reliability and with no chance of human error. The V44, recommended where high speed is essential, gives 200 readings per second, measures DC voltage from ± 0.001 to ± 999.9 with ± 0.01% accuracy, is completely automatic, and has a special output for data logging.

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LIVINGSTON LABORATORIES LIMITED

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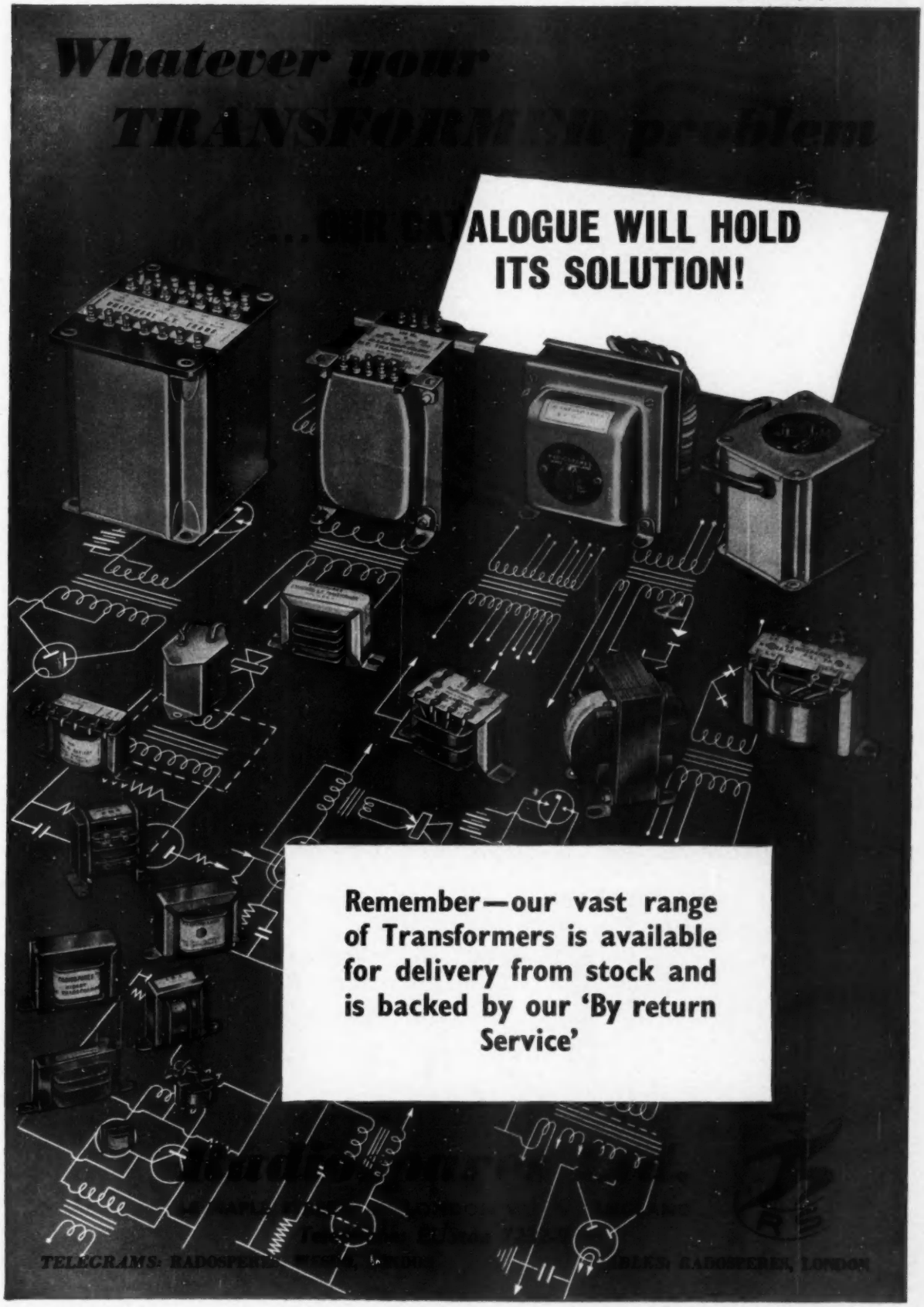
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ALOGUE WILL HOLD
ITS SOLUTION!
Remember—our vast range of Transformers is available for delivery from stock and is backed by our 'By return Service'

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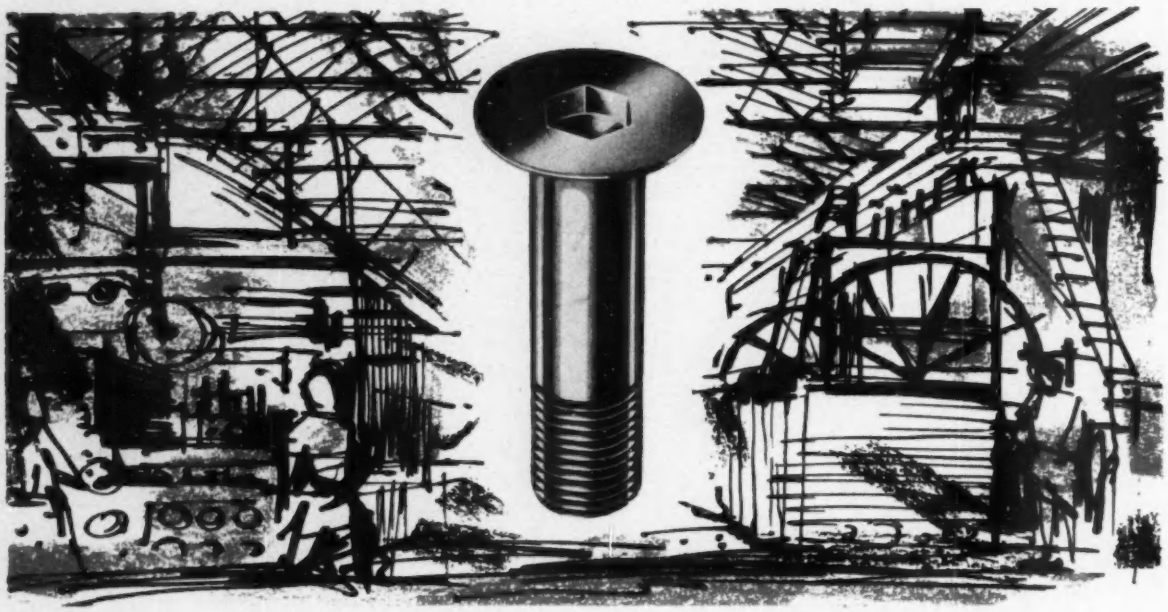
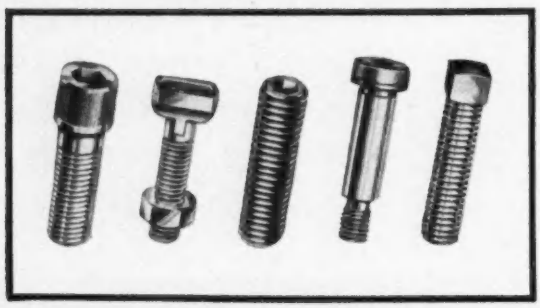
The screws with the fourth dimension

Any screw can present a faultless appearance. It can be measured optically, microscopically, scientifically, yet the vital dimension escapes physical detection.

That dimension is in-built performance. A basic characteristic of Unbrako screws which is proved by a negative. The fact that Unbrako screws do NOT fail industry even when subjected to the most prolonged of gruelling conditions.

Reliability stems from research. No screw in the whole wide world is backed by more research than Unbrako.





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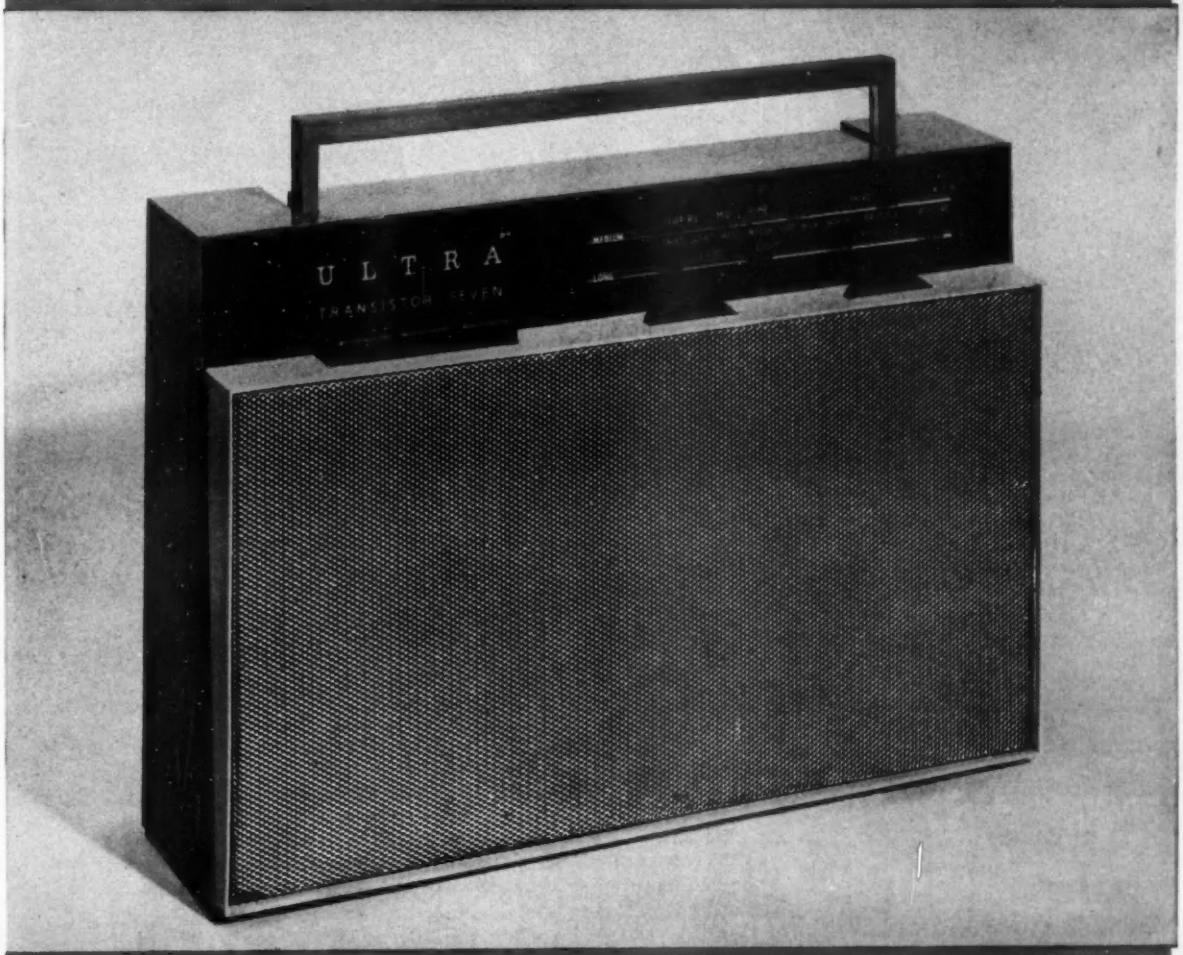
UNBRAKO SCHRAUBEN Gm. b. H. KOBLENZ · UNBRAKO STEEL CO. LTD., SHEFFIELD, ENGLAND

"... and here is a special message



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basking a little in the reflected glory of the Ultra TX70, congratulate ULTRA Radio and Television Ltd. and their designer Eric Marshall, F.S.I.A. on their award of The Duke of Edinburgh's prize for elegant design 1961. We cannot help but feel proud that the special flow characteristics of a BX moulding powder—in the hands of Injection Moulders Ltd.—so faithfully reproduced the intention of the designer."

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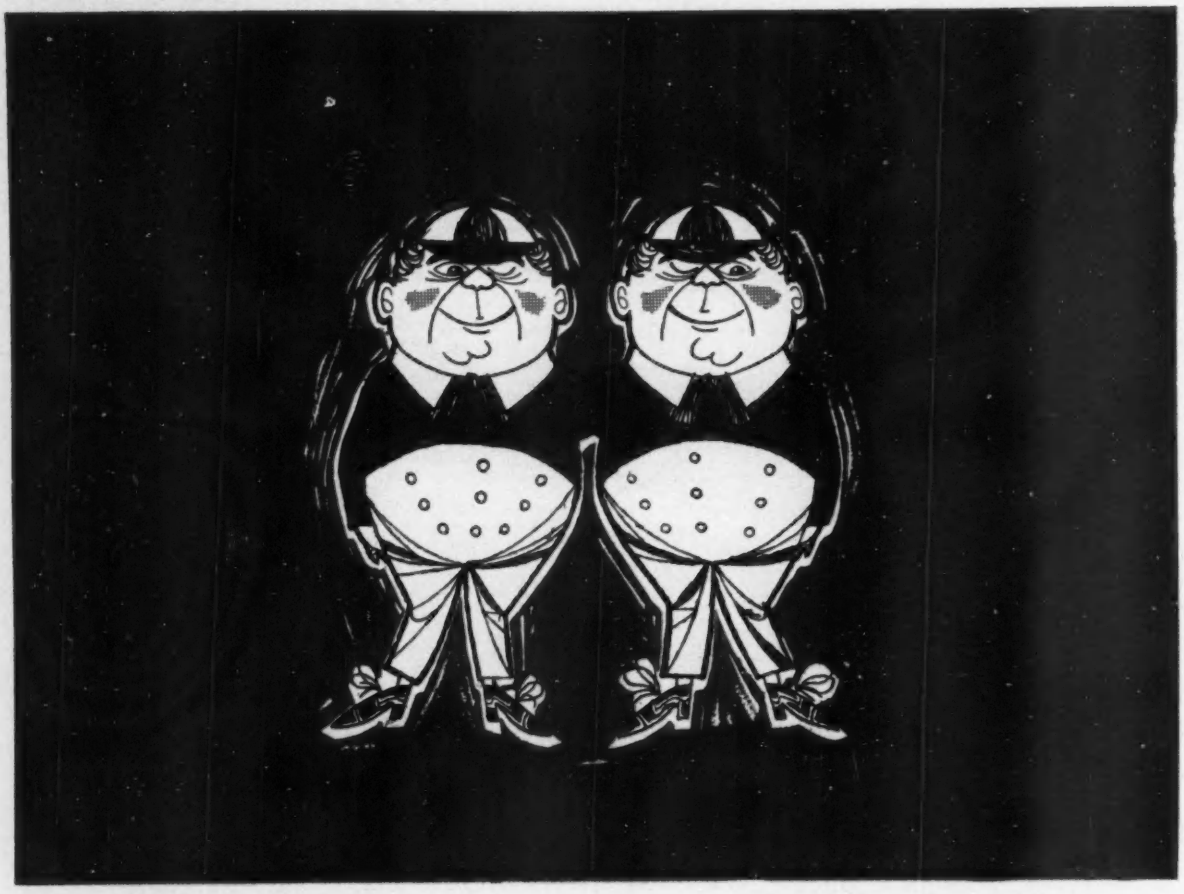


Tweedledum and Tweedledee

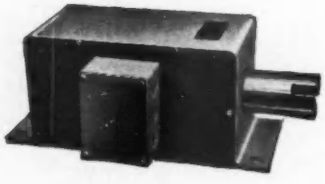
These two chaps seldom differ on any detail. They are quite unanimous about the excellence of Varley Solenoids when it comes to any job of pushing or pulling, to-ing or fro-ing, righting or lefting, inning or outing or any kind of symmetrical, reciprocal action.

Varley
REGD. TRADE MARK

solenoids

Type 'W.M.'

A solenoid of rugged, welded construction for heavy industrial applications which can be supplied to pull or thrust 12 lbs. to 180 lbs. through ¼" to 7" stroke, depending on rating. The coil is vacuum-impregnated and built-in Terminal Box and Surge Suppressor are fitted as standard. Base or Flange mounting available. This range is C.S.A. approved.



For full details of Varley Solenoids, write for Illustrated Catalogue L.1.

OLIVER PELL CONTROL LTD

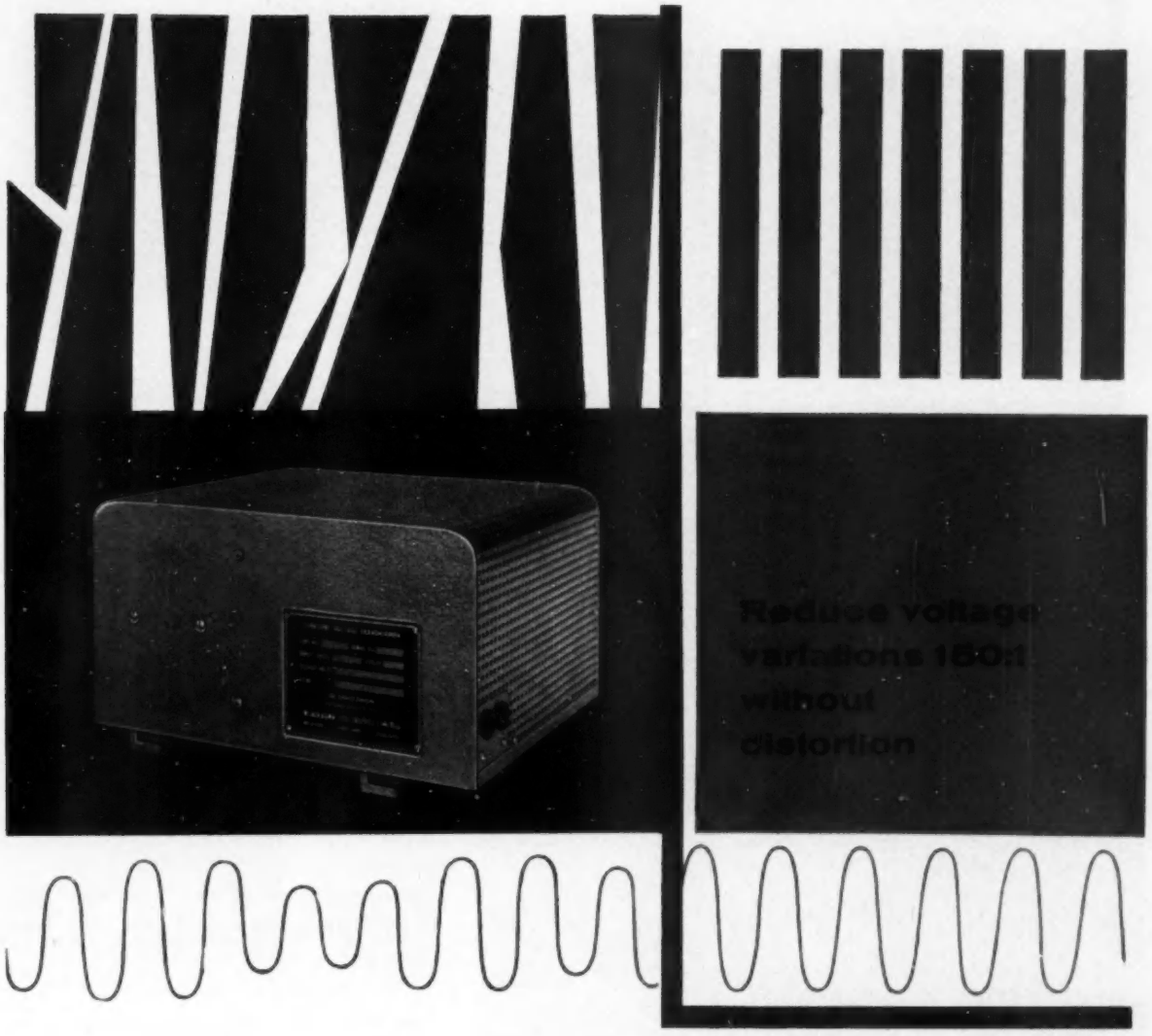
CAMBRIDGE ROW, BURRAGE ROAD, WOOLWICH, S.E.18

Telephone: Woolwich 1422 (five lines) Telegrams: Olipel, London, S.E.18.

T.A.4194

EE 36 064 *for further details*

'MAINSTAB' Constant Voltage Transformer with sine wave output



Stabilisation of mains voltages without distortion means that the B.E. 'Mainstab' Constant Voltage Transformers outdate all other mains stabilisers.

These unique Constant Voltage Transformers provide a major advance in the art of mains stabilisation. They may be used directly in front of electronic and electrical equipment sensitive to variations of both mains voltage and wave form.

All models have the following characteristics in the range of power ratings available:

Stabilisation Ratio	**150:1**
Efficiency at full load	**75%**
Regulation no load to full load	**5%**
Harmonic distortion	**less than 5%**
Input voltage	**180 to 260 volts, 50 c/s**

'MAINSTAB' Constant Voltage Transformer BIE 400

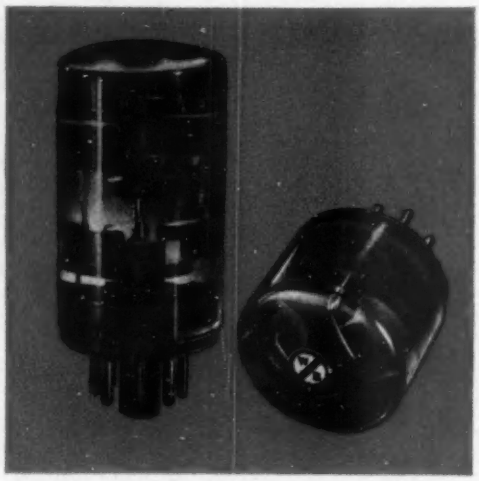
BLACKBURN ELECTRONICS LIMITED, BROUGH, YORKSHIRE

Telephone: Brough 121

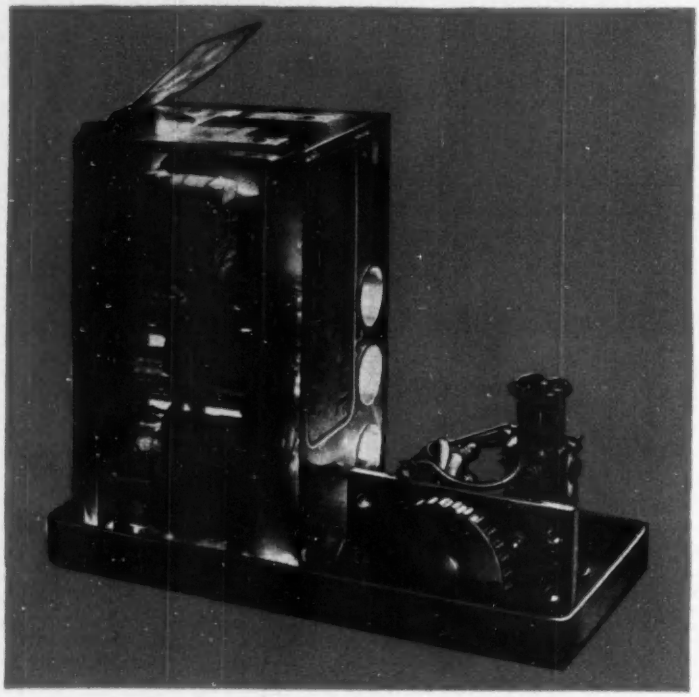
Member Company of Hawker Siddeley Aviation

EE 36 065 *for further details*

Comprehensive Cover



In literature describing their fault-locating equipment for Post Office use, Whiteley Electrical Radio Co. Ltd. have this to say about Araldite:



"The Araldite epoxy resins which we use provide mechanical and climatic protection, combined with excellent electrical insulation, for equipment used in extremes of temperature and humidity. Low shrinkage, excellent mechanical and electrical properties, and strong adhesion to components and leads afford positive protection at all times.

Such is the versatility of these resins that metals, ceramics, glass, mica, and laminated plastics can all be successfully bonded, giving exceptional strength and durability. A further important feature is the reduction in size and weight that can be achieved by encapsulation; while the characteristics of the resins provide complete waterproofing".

May we send you information regarding other uses of these remarkable epoxy resins?

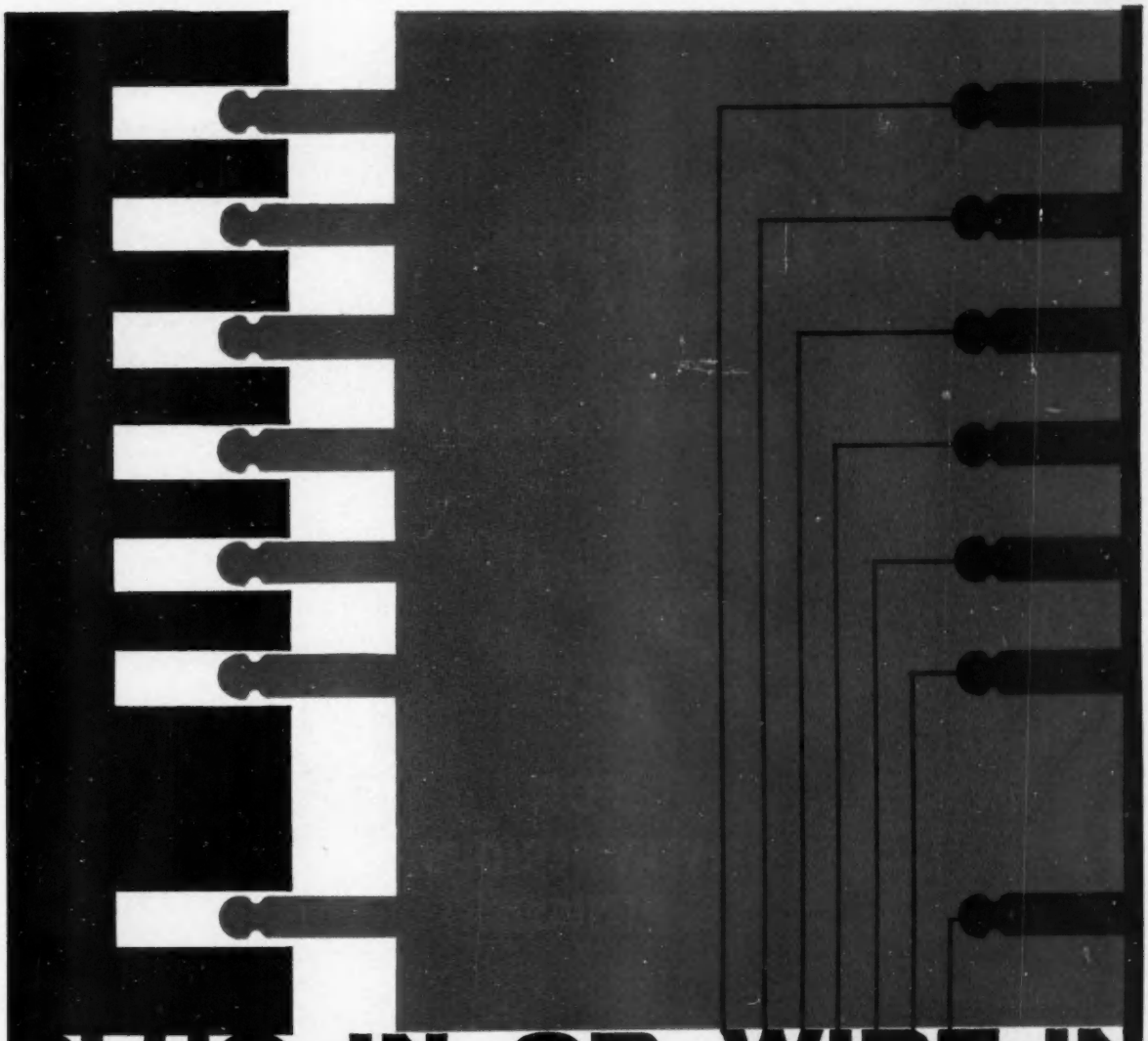
Araldite *epoxy resins*

Araldite is a registered trade mark

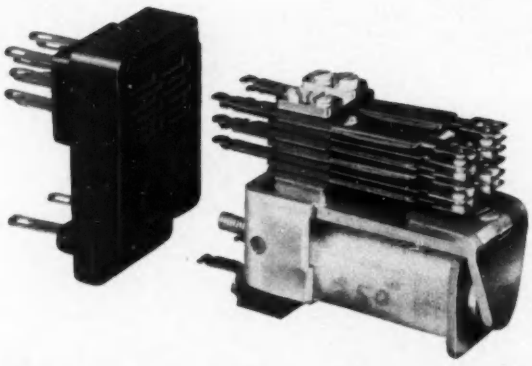
CIBA (A.R.L.) LIMITED

Duxford, Cambridge. Telephone: Sawston 2121

AP531



PLUG-IN OR WIRE-IN



Plug-in or wire-in, this is the choice—a difficult choice which frequently faces the equipment designer.

Although it is generally agreed that for the introduction of components into a circuit the most reliable method is to wire in, quite frequently conditions arise where the choice must be in favour of plugged-in components.

It is with this in mind that we offer the latest dual role G.P.S.T. miniature relay with its background of proven reliability. Complete with dust cover, clip and socket this adaptation offers not only the facilities of a plugged-in relay, but may where required be wired-in in the normal fashion.

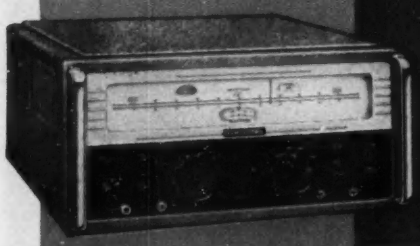
As in the earlier model the relay is capable of switching spring-set combinations of up to 12 normal duty contacts at speeds of better than 10 m.s.

For more detailed information please write to
TECHNICAL SERVICES DEPARTMENT

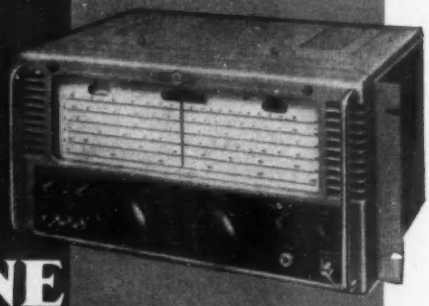
ELECTROMECHANICAL DIVISION
BEESTON · NOTTINGHAM

ERICSSON

ERICSSON TELEPHONES LTD · HEAD OFFICE · 22 LINCOLN'S INN FIELDS · LONDON WC2



Model "88" M ... stability MF receiver. Superb specification and performance—designed to meet professional requirements. Range 500 kc/s to 30 Mc/s. Dial setting accuracy within 1 kc/s. Combines the advantages of crystal control with continuous tuning.



Model "750/4" General Purpose MF receiver. Developed to meet a Government specification and capable of an excellent performance. Range 480 kc/s to 30 Mc/s. (Special versions available giving crystal control and low frequency coverage.)

THERE'S AN

EDDYSTONE

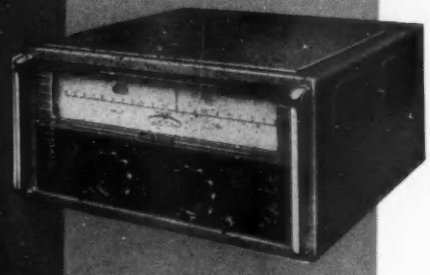
COMMUNICATIONS RECEIVER

FOR EVERY SERIOUS PURPOSE

Model "680/2" General Purpose LF/MF receiver. Range 10 kc/s to 600 kc/s in six overlapping bands. Full communication facilities.

Model "770U" Ultra High Frequency receiver, covering from 150 Mc/s to 500 Mc/s. Excellent performance throughout and suitable for receiving either FM or AM signals.

Model "770R" Very High Frequency receiver, covering from 19 Mc/s to 165 Mc/s in six ranges. Accepts AM, FM and CW. High sensitivity, fine control, thoroughly reliable.



Model "770S" Extra High Frequency receiver, having a range from 500 Mc/s to 1000 Mc/s. Specially developed circuitry gives high performance.

RADIO PRODUCTS EDDYSTONE TRADE MARK

Please write for full Technical Specifications to the Manufacturers

STRATTON & CO. LTD., BIRMINGHAM, 31

a unique source of INFORMATION on scientific instruments

There are two kinds of knowledge; knowing and 'knowing where to find out'. With science and technology developing so rapidly no one can hope to be fully informed on every worthwhile new technique or new equipment.

Here are three ways in which 'knowing where to find out' can help you:

(1) If you already know the answer to your problem but don't know who makes the most suitable equipment SIMA can tell you.

(2) If the answer to your problem depends on whether someone has already developed suitable equipment, SIMA will know if it exists and can tell you where to get it.

(3) If you just have a problem, SIMA can often tell you whether someone has already found the answer to it and has developed equipment to meet it.

Where do SIMA get their information?

From two sources. One is The British Scientific Instrument Research Association (BSIRA) which is constantly engaged in research and maintains extremely comprehensive libraries and files. The other is the membership, consisting of over 180 companies engaged in all these fields of instrumentation:

OPTICAL & OPHTHALMIC	LABORATORY & ANALYTICAL
ELECTRONIC & NUCLEONIC	MEDICAL & X-RAY
ENGINEERING & INDUSTRIAL	KINEMATOGRAPHIC
NAVIGATIONAL & SURVEY	PROCESS CONTROL & AUTOMATION

The Scientific Instrument Manufacturers' Association could be your most valuable source of such information and you will find them very helpful on *any* question about scientific instruments.

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Over 180 manufacturers with one address

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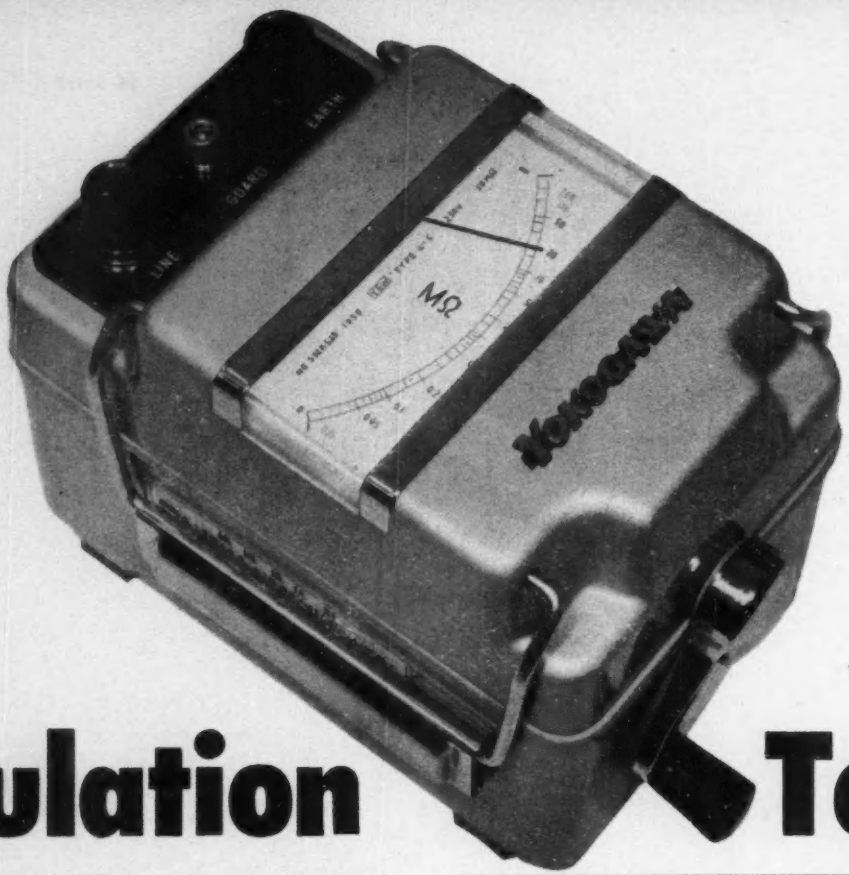
Telephones—Secretariat Langham 4251 Enquiry Service Imperial 6000

Space donated by member: **AIRMEC LIMITED,** High Wycombe, Bucks.,
Manufacturers of Electronic Instruments and Industrial Control Equipment.



Type L-5

Insulation Tester

EXPANDED SCALE YEW Type **L-5** has a long and electrically expanded scale which covers 5 decades of resistance.

QUICK RESPONSE The quick response of Type **L-5** will help you read the insulation resistance instantly.

SILENT GENERATOR The rotary magnet type generator turns extremely smooth and silent because of its excellent dynamic balance.

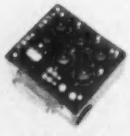
CORE MAGNET SYSTEM INDICATOR The indicator employs a core magnet system in which the yoke acts as a self-shield to minimize the external field influence.

GOOD DESIGN YEW Type **L-5** has a graceful appearance with gray colored aluminum case with a wide window.

Type	Rated Voltage / Rated Resistance	Range			Effective Measuring Range
L-5	100V / 20M Ω	0~∞ Ω	Lowest scale line Highest scale line	2k Ω 100M Ω	0.02~20M Ω
	250V / 50M Ω	〃	〃 〃	0.01M Ω 200M Ω	0.05~50M Ω
	500V / 100M Ω	〃	〃 〃	0.01M Ω 500M Ω	0.1~100M Ω
	500V / 1,000M Ω	〃	〃 〃	0.1M Ω 5,000M Ω	1~1,000M Ω
	1,000V / 2,000M Ω	〃	〃 〃	0.5M Ω 10,000M Ω	2~2,000M Ω
L-5 B	2,000V / 5,000M Ω	〃	〃 〃	0.5M Ω 20,000M Ω	5~5,000M Ω

Portable Instrument

Panel Instrument

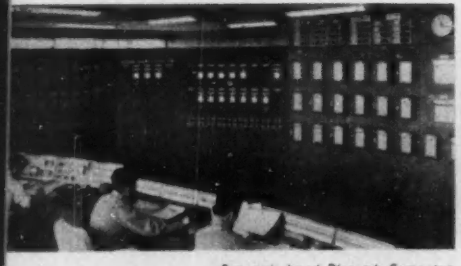


Wheastone Bridge

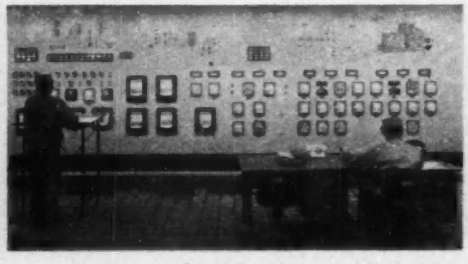
Earth Resistance Tester

Q-Meter

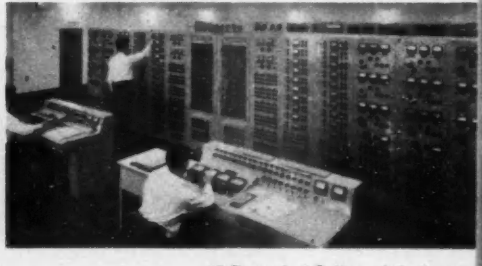
All-Electronic Recording Controller



Economic Load Dispatch Computer



Central Control Station of Chemical Plant



All-Electronic A.C. Network Analyzer

YOKOGAWA ELECTRIC WORKS, LTD.

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Leaders in Electrical Measuring Instruments for 50 years

Head Office: 3,000 Kichijoji, Musashino-shi, Tokyo, Japan New York Office: YOKOGAWA ELECTRIC WORKS, INC.; 40 Worth St., New York, N.Y.
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Sole Distributor in Australia: FOXALL INSTRUMENTS PTY. LTD.; 1213-1217 High Street, Armadale, S.E. 3, Melbourne
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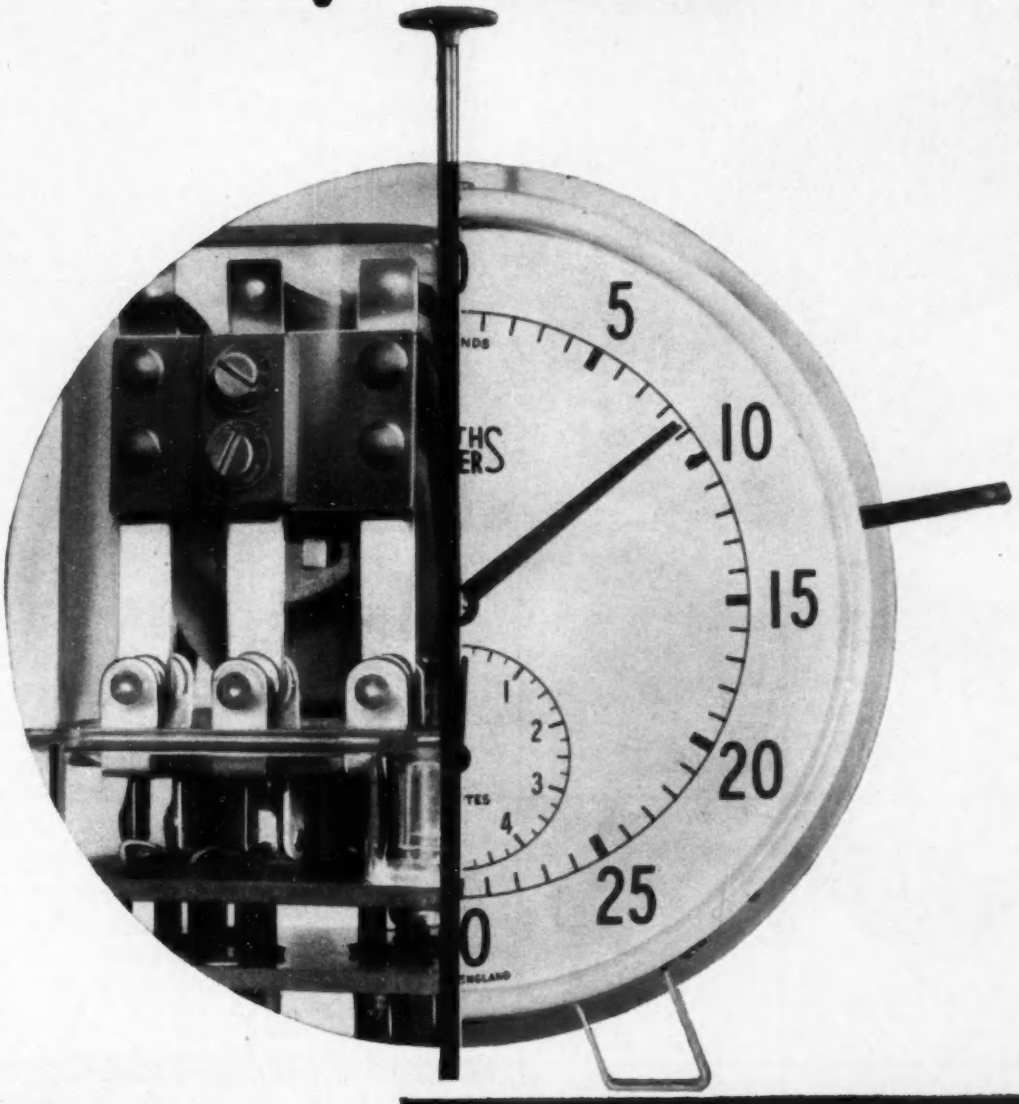
EE 36 070 *for further details*

Relay's better half



Quality control is continuous throughout the B. & R. manufacturing process. We test the materials, the machinery, the operator, the component parts and the production line. And we test every relay individually for final performance.

In fact, it is no exaggeration to say that a full 50% of the manufacturing time spent in producing a B. & R. relay is spent in testing. Which is what B. & R. mean when they talk about reliability.

RELAY/CONTACTOR TYPE Q.51. Patent Pending. C.S.A. Approval applied for. This A.C. operated unit has been designed to comply with BSS 775—1956, Clause 5-6 Class IV, being suitable for 440 volts 50 c/s 3 phase supplies with an inductive 10 amp rating. This relay is available in two versions, the Q.51/2 (2 Bank) and Q.51/3 (3 Bank). The coil may be removed quickly and easily without disturbing the body of the relay and the contacts are readily interchangeable.

COIL. Suitable for voltages up to 440 volts 50 c/s. Energising VA=30. Closed VA=7.

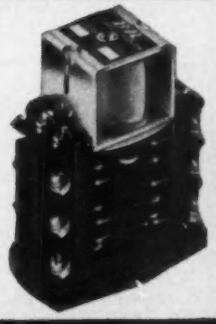
OPERATING SPEED. Pull-in (*2 Bank*) 10-30 ms. (*3 Bank*) 10-30 ms. Drop-out (*2 Bank*) 10-25 ms. (*3 Bank*) 15-25 ms.

CONTACTS. Silver cadmium oxide rated at 10 amps 415 volts 50 c/s.

TROPICALISATION. The relay may be tropicalised to DEF 5000.

TERMINALS. Rising type, captive clamp to hold two 7/0.029 cables. VOLTAGE PROOF. 2000 volts R.M.S.

WEIGHT. 2 Bank 11 oz. 3 Bank 13 oz.



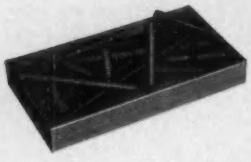
B & R RELAYS LIMITED

TEMPLE FIELDS, HARLOW, ESSEX

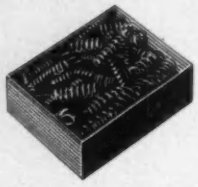
Telephone: Harlow 25231/4

Member of the Gas Purification Group

EXPERIMENTAL SPRINGS?

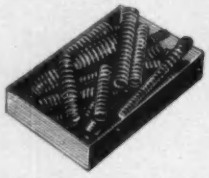


No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **15/-.**



No. 98A. Three dozen Assorted 1″ to 4″ long, $\frac{1}{4}$″ to $\frac{3}{8}$″ diam., 19G to 15G. **6/6.**

No. 753. Three dozen Assorted Light Expansion $\frac{1}{2}$″ to $\frac{1}{4}$″ diam., 2″ to 6″ long, 22 to 18 S.W.G. **12/-.**



No. 760. Three dozen Assorted Light Compression Springs. 1″ to 4″ long, 22 to 18 S.W.G., $\frac{1}{4}$″ to $\frac{1}{2}$″ diam. **7/6.**

No. 757. Extra Light Compression, 1 gross Assorted, $\frac{1}{4}$″ to $\frac{1}{2}$″ diam., $\frac{1}{2}$″ to 2$\frac{1}{2}$″ long, 27 to 19 S.W.G. **18/-.**

No. 758. Fine Expansion Springs. 1 gross Assorted $\frac{1}{2}$″ to $\frac{3}{8}$″ diam., $\frac{1}{2}$″ to 2″ long, 27 to 20 S.W.G. **18/-.**

That spring you want . . . in a hurry . . . *where* is it? Pick *what* you want *when* you want it from TERRY'S BOXES OF ASSORTED SPRINGS—our fine range of small boxed assortments of experimental springs. We can show you only a few from the range here. Send a postcard for our full list—and if ever you're stuck with a spring problem send it along to our Research Department —they'll gladly help you out.

Have you a Presswork problem?

If so, the help of our Design Staff is yours for the asking.

TERRY'S *for SPRINGS*

Really interested in Springs? "Spring Design and Calculations" 10th Edition tells all—post free 12/6.

Cut Production Costs with Terry's Wire CIRCLIPS. We can supply immediately from stock—from $\frac{1}{8}$″ to $\frac{1}{2}$″.

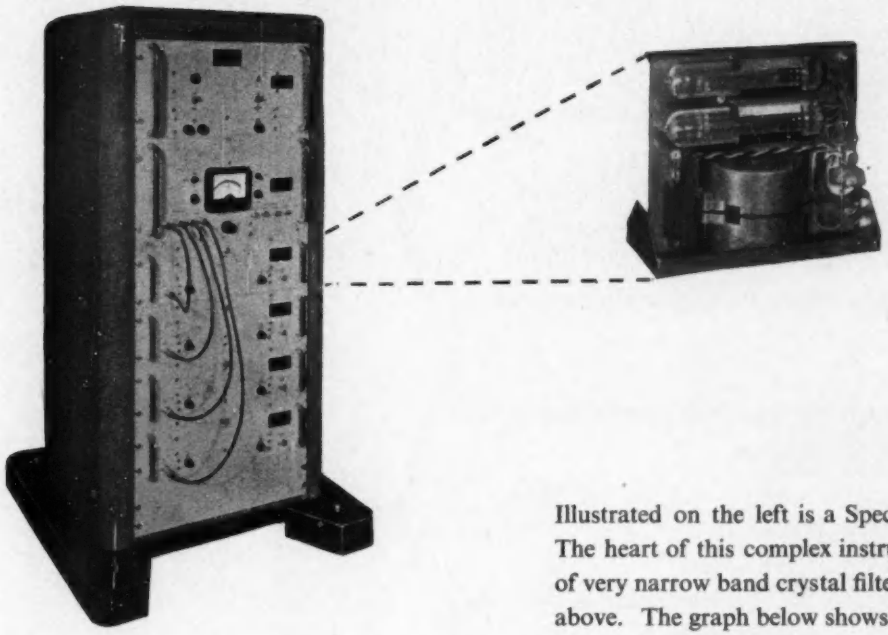
Looking for good Hose Clips? Send for a sample of Terry's Security Worm Drive Hose Clip and price list.

HERBERT TERRY & SONS LTD

Redditch, Worcs.

(Makers of Quality Springs, Wireforms and Presswork for over 100 years)

HT31

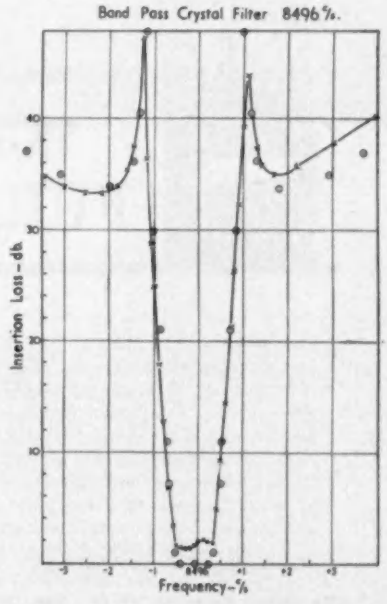


Illustrated on the left is a Spectrum Analyser. The heart of this complex instrument is a bank of very narrow band crystal filters as illustrated above. The graph below shows the response of a typical filter of this type. The instrument also includes d.c. amplifiers of very high stability.

The Spectrum Analyser illustrates the range of equipment which we design and manufacture to special requirements.

ELECTRIC WAVE FILTERS

- ★ Filters designed for band pass, low pass, high pass or band stop characteristics.
- ★ Frequency range is approximately 0-20 Mc/s.
- ★ Filters designed by modern techniques to a given specification.
- ★ Filters for use in multichannel systems.
- ★ Filter amplifiers and active filters for use at low frequencies.

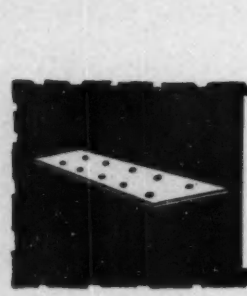


BARR & STROUD LTD.

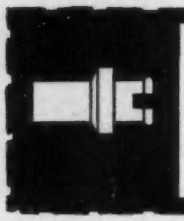
ANNIESLAND, GLASGOW, W.3

London Office: Kinnaird House, 1 Pall Mall East, S.W.1

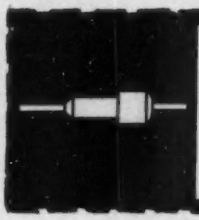
EE 36 073 *for further details*



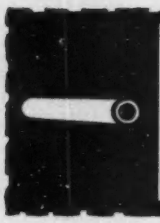
TERMINAL BOARDS



LUGS



MOULDED INSULATORS



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HARWIN

Harwin *make* components—*specialise* in components. Lugs, moulded insulators, terminal boards and chassis furnishings. 'Off-the-shelf' or to special design.
The *quality* of every Harwin component is the product of experienced, precision manufacture and rigid inspection—meeting, and in many cases surpassing standard specifications. In addition, Harwin *service* and *specialisation* in fulfilling individual needs is something to be experienced—talk over *your* component problems with Harwin and be sure of the *best* and most *effective* answer.

SERVICE AND QUALITY

HARWIN ENGINEERS LTD RODNEY ROAD PORTSMOUTH · HAMPSHIRE · Tel: Portsmouth 35555 (4 lines)

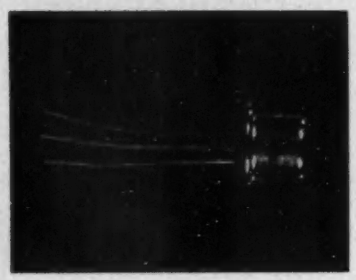
We grew up in a field of PRECIOUS METALS

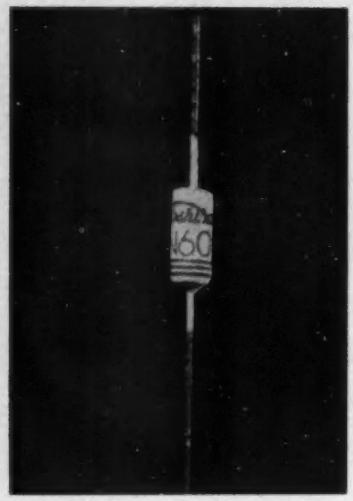
Entering our third century, we can rightly claim to know an awful lot about this precious industry of ours. "Resting on our Laurels", however, is not for us—we prefer to think of laurels as repeat orders . . . our repeat orders have come by the hard way—by the continuous service we have maintained through two whole centuries to the Precious Metal Industry—and that is a long time . . . If you can use our experience, skill, and service, for silver solders, brazing alloys, electrical contacts and contact materials, or precious metals in any form, give us a call—you'll find we are 'old hands at the game'.

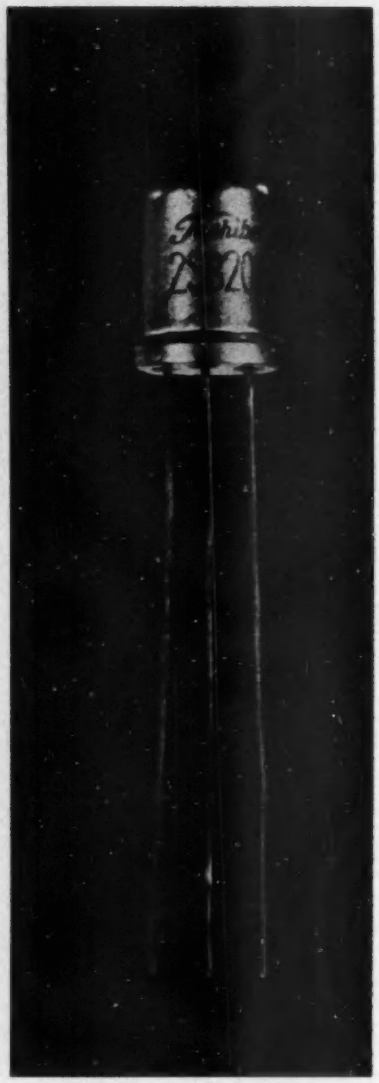
The SHEFFIELD SMELTING COMPANY LIMITED

HEAD OFFICE AND WORKS: ROYDS MILL STREET, SHEFFIELD, 4.
ALSO AT LONDON AND BIRMINGHAM.

Toshiba







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2SA58	For High Frequency Amplification (12Mc)
2SA60	For Converter Service (12Mc)
2SA72	For High Frequency Amplification (1.5Mc)
2SA73	For Converter Service (1.5Mc)
2SA92	For Local Oscillator Service (18Mc)
2SA93	For Mixer Service (12Mc)
2SA76	For High Frequency Amplification (VHF•FM)
2SA77	For High Frequency Amplification (VHF•FM)
2SA175	For High Frequency Amplification (22.5Mc)
2SA236	For Intermediate Frequency Amplification (455Kc)
2SA237	For Intermediate Frequency Amplification (455Kc)

Germanium PNP Mesa Type Transistor

2SA299	For Mixer & Local Oscillator Service (TV Tuner)
2SA230	For High Frequency Amplification (TV Tuner)
2SA239	For Converter Service (VHF•FM)
2SA240	For High Frequency Amplification (VHF-FM)

Germanium Point Contact Diode

1N60	For AM/FM Radio & Video Detector Service
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1S34	For General Service

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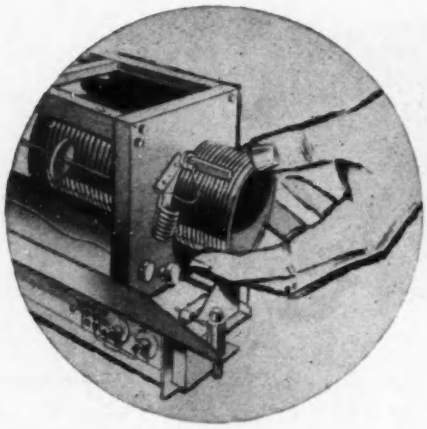

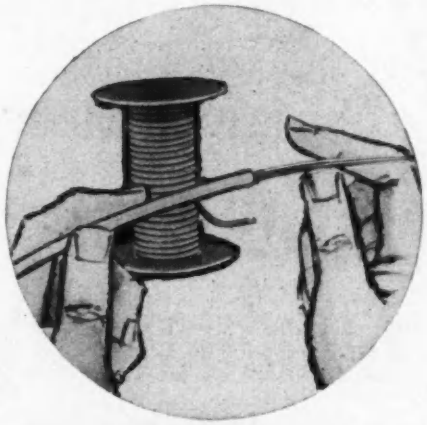

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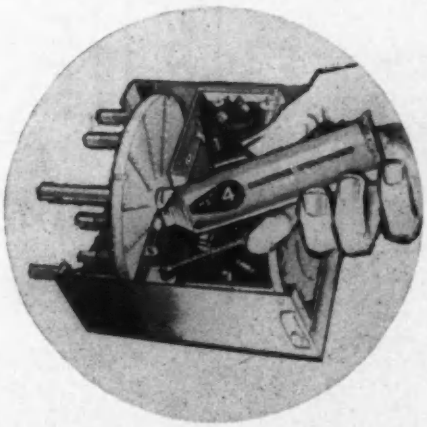

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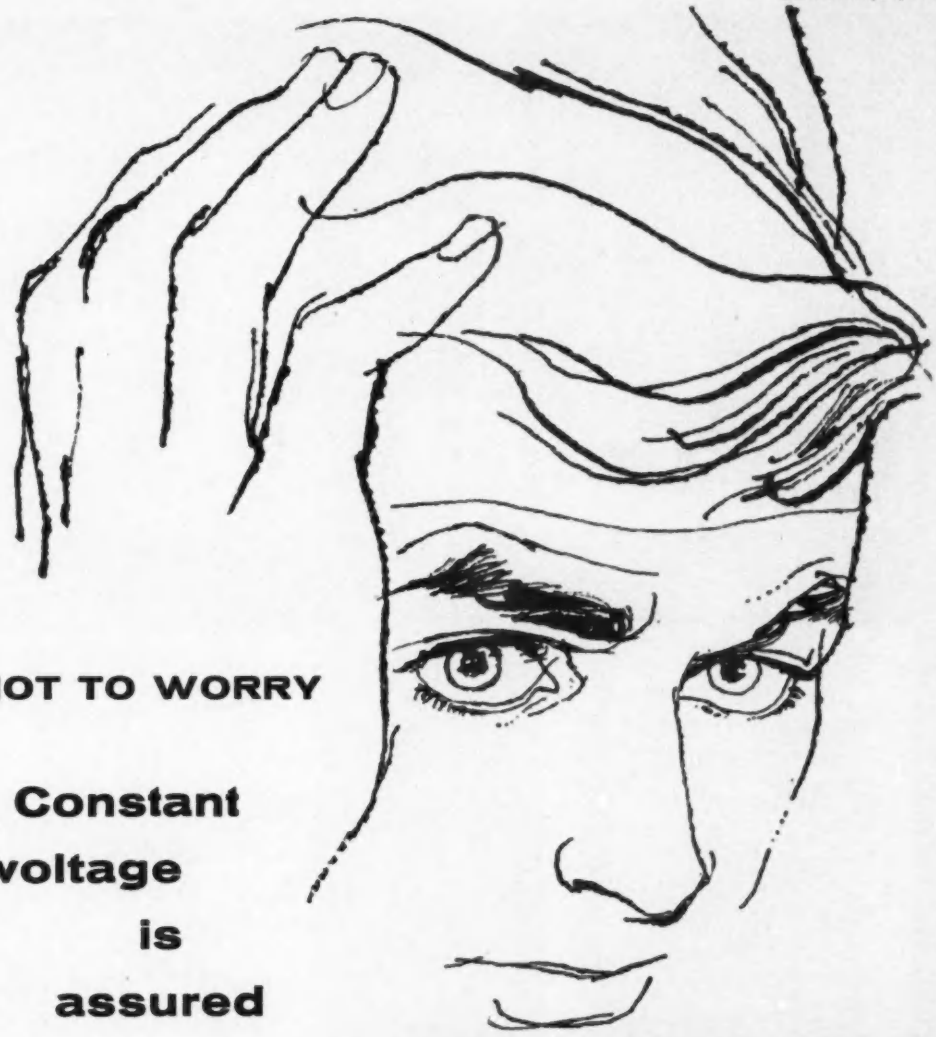

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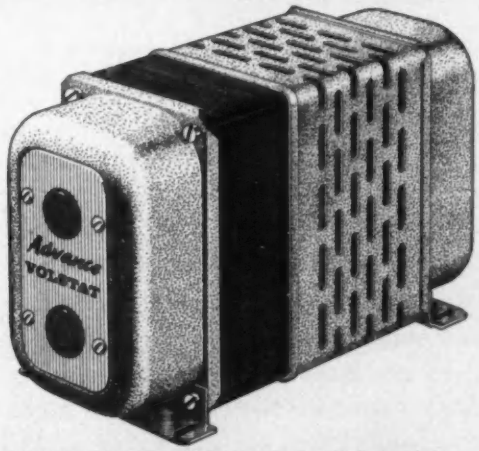

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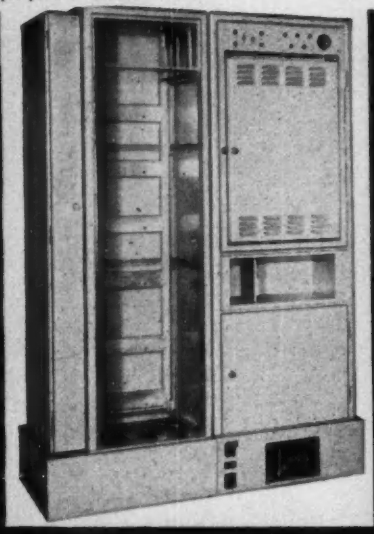

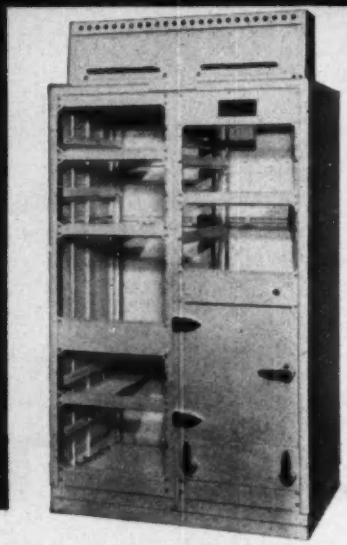

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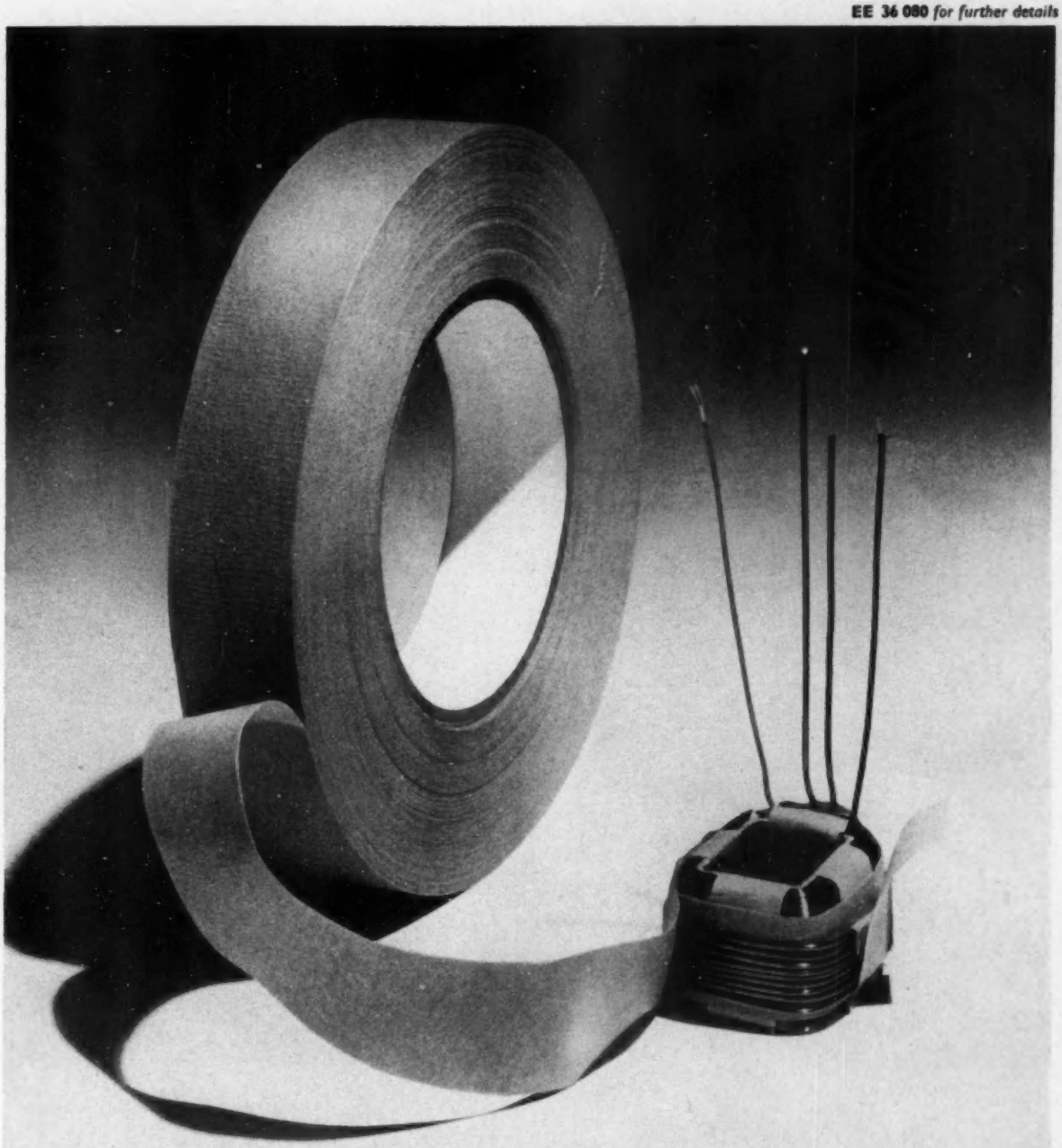

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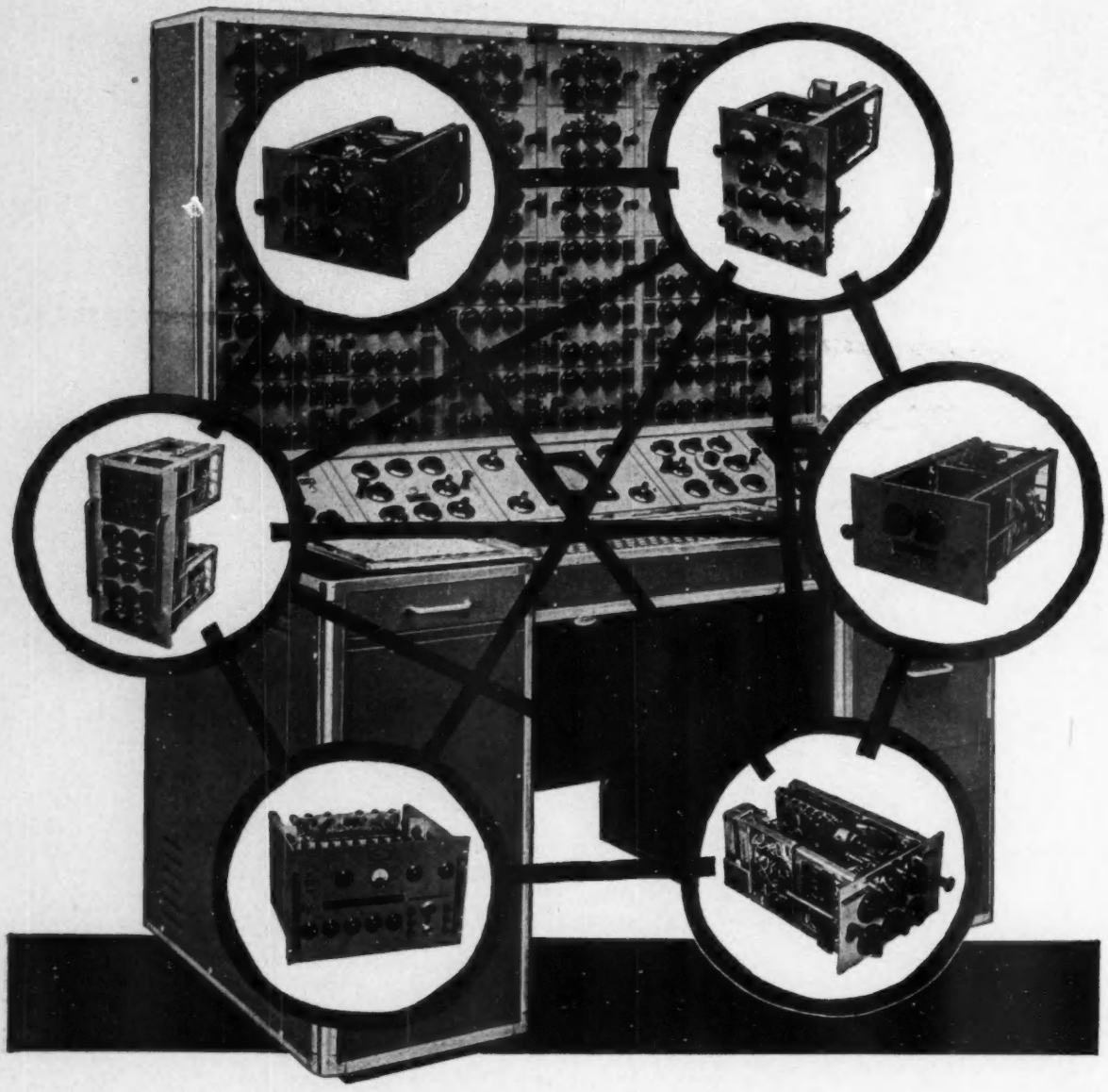

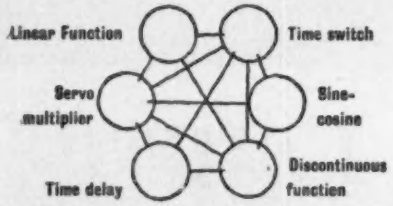

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COMPONENTS REVIEW

NEW 7½ WATTS ZENER REFERENCE DIODES

This new SenTerCel range of 7·5W silicon voltage reference diodes is manufactured using diffusion techniques and, when operated with a 7 in. x 7 in. heat sink, can be used up to 85°C ambient at the full rating.

The diodes have a low turnover voltage in the reverse direction and are available in the range 6·8 to 51 volts with 5%, 10% and 20% tolerance. The reverse characteristic beyond the turnover point enables the diode to be used as a voltage regulator over different circuit currents or as a voltage stabiliser, limiter or reference.

The Z5 series uses the E.I.A. scheme of coding for preferred valves, the code number being in principal equal to ten times its normal voltage.

Write for Advance Information Leaflet to STC Rectifier Division, Edinburgh Way, Harlow, Essex.

Z5A ZENER VOLTAGE REGULATOR DIODES 7·5W

Code	Nominal Voltage at —50mA (Volts)	Typical Slope Resistance at 50mA (Ohms)	Maximum Continuous Current for ±20% Tolerance (mA)
Z5A.68F	6·8	2·0	900
Z5A.75F	7·5	2·0	800
Z5A.82F	8·2	2·0	730
Z5A.91F	9·1	2·0	670
Z5A.100F	10	2.0	610
Z5A.110F	11	2·1	520
Z5A.120F	12	2·1	490
Z5A.130F	13	2·1	460
Z5A.150F	15	2·1	410
Z5A.160F	16	2·1	370
Z5A.180F	18	2·1	340
Z5A.200F	20	2·1	310
Z5A.220F	22	2·2	275
Z5A.240F	24	2·3	245
Z5A.270F	27	2·5	225
Z5A.300F	30	3·0	205
Z5A.330F	33	3·4	190
Z5A.360F	36	3·8	175
Z5A.390F	39	4·3	160
Z5A.430F	43	5·0	145
Z5A.470F	47	5·7	135
Z5A.510F	51	6·6	125

NEW RANGE OF MINIATURE CRYSTALS

TO REPLACE STC TYPE 4407 (55-83 kc/s)

AND STC TYPE 4028 (75-140 kc/s)

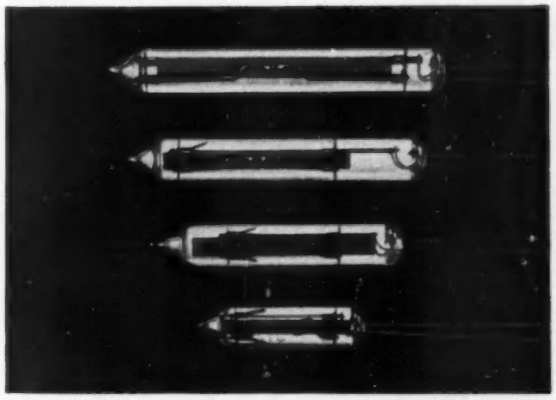
STC has developed a range of small low-frequency crystals for use in miniature equipments. These units are in evacuated glass envelopes of only 0·4 in. (10 mm) diameter and have wire leads. Length is dependent on frequency as follows:—

Frequency Range kc/s	STC Type	Maximum seated height		Volume		Lead length	
		in.	cm	cu. in.	cu. cm	in.	cm
57 – 62·9	4432	2·83	7,19	0·36	5,90	1·5	3,8
63 – 71·9	4438	2·44	6,19	0·31	5,08	1·5	3,8
72 – 99·9	4437	2·04	5,18	0·26	4,26	1·5	3,8
100 – 150	4435	1·45	3,68	0·18	2,95	1·5	3,8

The new crystal units provide a saving in space of over 60%. They are ideal for horizontal mounting on transistorized printed circuits.

It is intended, in the near future, to extend the frequency range down to 10 kc/s to replace types using the present B7G mounting.

Write for further information to STC Quartz Crystal Division, Temple Field, Harlow, Essex.



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LOW NOISE TWT EXTENDS RADAR RANGE

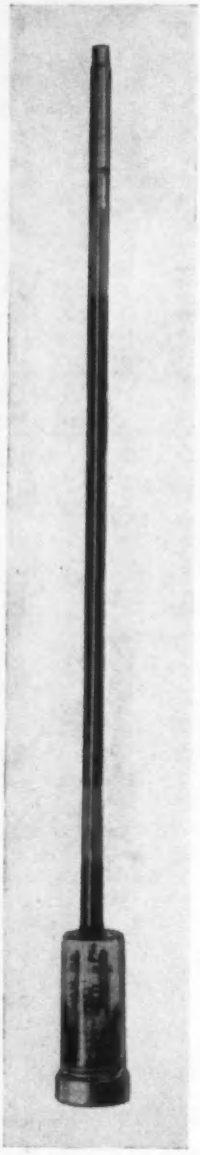
A limitation on the effective range of a radar equipment is the noise level in the receiver: the limiting range is reached when signal to noise ratio approaches unity. The signal to noise ratio in the equipment cannot be better than that in the first stage, therefore the use of a low noise amplifying tube in that stage is of paramount importance.

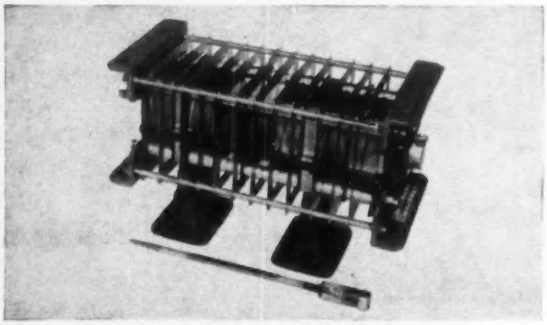
STC offers two tubes of eminently suitable design for use in S-band:

Type W9/2E for broadband coverage with a gain of 40 dB and noise factor of about 8·5 dB. It is intended for operation over the whole frequency range 2·5 to 4·1 Gc/s with fixed voltages. An aluminium foil mount is available with coaxial r.f. connectors.

Type W10/3E for narrow band operation with about 23 dB gain and 6·5 dB noise factor with the grid voltages set for optimum noise factor at the appropriate centre frequency.

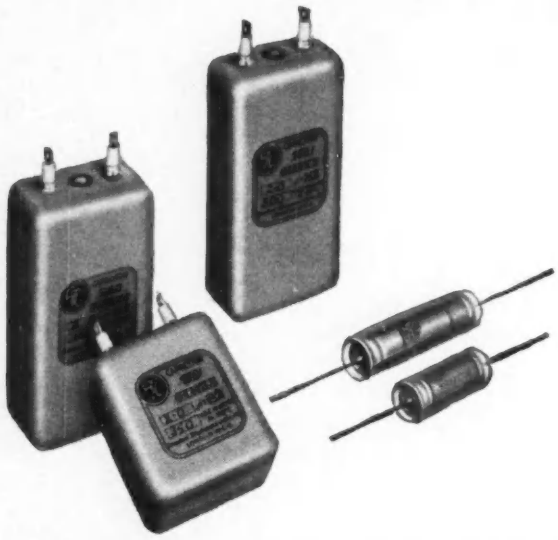
W10/3E has a frequency range 2·7 to 3·3 Gc/s in solenoid circuit 495—LVA—003 with waveguide r.f. connectors or frequency range 2·8 to 3·8 Gc/s in solenoid circuit 495—LVA—006 with coaxial r.f. connectors.





Apply to STC Valve Division, Footscray, Sidcup, Kent, for Brochure MS/113.

OIL-FILLED PAPER CAPACITORS



STC Oil-filled Paper Capacitors are manufactured with rectangular and tubular construction. Both types provide a range of capacitors offering a high stability of electrical characteristics over an extensive life at operating temperatures of from –40°C to 100°C.

Sintered glass compression type seals are used on the tubular types and the rectangular cases have Corundite sealing. The oil-filled construction renders the capacitors suitable for a.c. or d.c. applications and the design is such that the devices will withstand severe vibration conditions. The capacitors conform to Category H.1. of RCS131 and BS2131.

TUBULAR METAL CASES

Capacitance Range: 0·0033 μF to 1·50 μF
Voltage Ranges: 100V to 350V d.c. 75V to 250V a.c.
Capacitance Tolerance (20°C):
Up to 0·01 μF ± 25%
Greater than 0·01 μF ± 15%
Insulance at 300V after 1 min: 5 000 ΩF, or 25 000 MΩ, whichever is less
D.C. test voltage: 3 times the rated working voltage at 70°C

RECTANGULAR METAL CASES

Capacitance Range: 0·25 μF to 10·0 μF
Voltage Ranges: 150V to 1 500V d.c. 75V to 750V a.c.
Capacitance Tolerance (20°C) ± 15%
Insulance at 300V after 1 min: 5 000 ΩF, or 25 000 MΩ, whichever is less
D.C. test voltage: 3 times the rated working voltage at 70°C

Write for Technical Data Sheets to STC Capacitor Division, Brixham Road, Paignton, Devon.

NEW SILICON EPITAXIAL PLANAR n-p-n TRANSISTORS

The Transistor Division is now producing the new silicon epitaxial planar transistors. This type of structure gives better saturation characteristics than the conventional mesa structure and represents a further landmark in the rapid advancement of STC semiconductors. The initial range comprises four transistors for fast switching and high frequency oscillator applications.

Brief data are given below.

For further information apply to STC Transistor Division, Footscray, Sidcup, Kent.

Characteristics	TK202A	TK203A	TK252A	TK253A	
f_T Common emitter gain-frequency product at I_C=20mA V_{CE}=9V, f=20 Mc/s	50	100	50	100	Mc/s (min)
V_{CES} Collector-to-emitter saturation voltage at I_C=100mA			0·8 (I_B=10mA)	0·8 (I_B=6mA)	V (max)
I_C=200mA	1·0 (I_B=20mA)	1·0 (I_B=12·5mA)			V (max)
I_{CBO} Collector-to-base leakage current at V_{CB}=9V, I_E=O	1·0	1·0	1·0	1·0	m μA (typ)
Ratings					
V_{CBM} with emitter open circuited or reverse biased	40	40	40	40	V
V_{CEM} with base open circuited	20	20	20	20	V
V_{EBM} reverse direction	6	6	6	6	V
I_{CM} (mean)	0·5	0·5	0·5	0·5	A
P_{CM} unmounted	2·5	2·5	0·6	0·6	W
in a heat sink	10	10			
T_{JM}	150	150	150	150	°C
JEDEC Outline	TO—3	TO—3	TO—9	TO—9	

STC HIGH 'Q' STANFERITE POT CORES FOR FILTER COILS AND OTHER APPLICATIONS

The range of STANFERITE air-gapped pot cores is provided with a minimum setting inductance adjustment of −3% or −5% to +5%. This is achieved by rotating one half of the pot core relative to the other, and is produced by an asymetric airgap resulting in a flux distortion. This is used primarily to compensate for the spread in capacitor and other component tolerances associated with the inductor, without recourse to mechanical adjustment of the airgap, and in so doing enables a standard number of turns to be used.

Technical Data Sheets available from STC Magnetic Materials Dept., Edinburgh Way, Harlow, Essex.

TYPE	DIMENSIONS (Approx.)		INDUCTANCE RANGE (Nominal)	FREQUENCY RANGE (Nominal)	'Q' RANGE (Nominal)	EFFECTIVE PERMEABILITY		HYSTERESIS FACTOR MAXIMUM	
	Diameter in.	Height in.				With gap	Without gap	With gap	Without gap
PC1	0·25	0·16	30μH to 9mH	—	—	—	>400	—	3 000
PC1A	0·25	0·1	30μH to 6mH	—	—	—	>400	—	3 000
PC2	0·5	0·32	30μH to 100mH	500c/s to 3Mc/s	30 to 300	25, 50, 100, 150	>600	4·6 to 67	550
PC3	0·75	0·57	30μH to 1H	200c/s to 3Mc/s	30 to 300	25, 50, 100, 150	>900	4·1 to 60	890
PC4	1·0	0·68	30μH to 5H	100c/s to 3Mc/s	30 to 600	25, 50, 100, 150	>1 000	1·6 to 21·5	370
PC5	1·5	1·0	30μH to 15H	50c/s to 2Mc/s	30 to 1 000	25, 50, 100, 150	>1 200	0·97 to 15	340

EE 36 087 *for further details*

No. 3 IN THE SERIES

Technical Information for the Transistor Circuit Designer

Stability factor

The stabilisation of the operating point of transistors over a wide temperature range is vital in most applications and is normally achieved by the choice of the right biasing network. This network can take one of the forms shown in figure 1.

The stability factor S (i.e. the number of times the leakage current is amplified in the circuit) is given by:

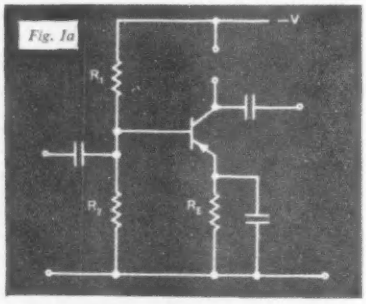
Figure 1*a*. $$S=\frac{\triangle I_C}{\triangle I_{CBO}}\simeq\frac{1+\dfrac{R_E}{R_B}}{\left(1-\alpha+\dfrac{R_E}{R_B}\right)} \quad \text{where } R_B=\frac{R_1 R_2}{R_1+R_2}$$

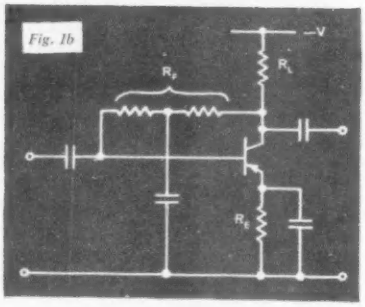
Figure 1*b*. $$S\simeq\frac{1+\dfrac{R_E}{R_F}}{\left(1-\alpha+\dfrac{R_L+R_E}{R_F}\right)}$$

Figure 1*c*. $$S\simeq\frac{1+\dfrac{R_F}{R_B'}}{\left(1-\alpha+\dfrac{R_L}{R_F}+\dfrac{R_E}{R_B'}\right)} \quad \text{where } R_B'=\frac{R_F R_2}{R_F+R_2}$$

The above are approximations because it is assumed that the external resistors R_E, R_1, R_2 and R_F are of much higher value than the transistor's internal parameters r_e and r_b, of the T-equivalent circuit. It should be noted that a *low* value of S is desirable and that S can never be less than unity. The highest value of junction temperature in a particular circuit will determine a practical value for S, because $S.I_{CBO}$ must be less than the desired value of I_C at the highest temperature.

In power output stages it is not always possible to tolerate the loss associated with the emitter resistor and the stability factor will suffer. The use of a temperature sensitive resistor can solve this problem and this will be discussed in No. 5 of this series.





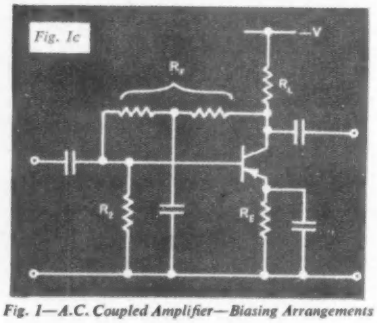


Fig. 1—A.C. Coupled Amplifier—Biasing Arrangements

(T_{amb}=25°C unless otherwise stated)

Type	Description and Applications	h_{FE} measured at					f_{hb} Typ. Mc/s	V_{CB} Max. (V)	V_{CE} Max. (V)	T_{junc} Max. (°C)	P_c max at 25°C (mW)
		Min.	Typ.	Max.	V_C (V)	I_C (mA)					
	GERMANIUM ALLOY JUNCTION TRANSISTORS										
TK30C	P n p. Excellent switching performance at relatively high collector currents. Very low saturation resistance.	20	40	*85	−4·5	−1·0	6·0	−30	−10	75	200
TK31C	Similar to the TK30C, but with a cut-off frequency greater than 8 Mc/s.	20	60	150	−4·5	−1·0	11	−20	−5	75	200
TK41C	P n p. Particularly suitable for low power audio frequency amplifiers.	20	40	55	−12	−1·0	0·5 min.	−40	−20	75	200
TK42C	Similar to the TK41C, but giving greater current gain.	45	70	150	−12	−1·0	0·5 min.	−40	−15	75	200

*95% Limit.

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Type No.	Continuous Ratings 25°C		Characteristics @ 25°C	
	Peak Inverse Volts	Max. Forward Current	Min. Forward Current at 1V	Max. Reverse Current at 50V
HG1001	100	45 mA	20 mA	50 μa
HG1002	100	45 mA	20 mA	100 μa
HG1003	100	45 mA	10 mA	50 μa
HG1004	100	45 mA	10 mA	100 μa
HG1005	100	45 mA	5 mA	50 μa
HG1006	100	45 mA	5 mA	100 μa
HG1007	75	45 mA	20 mA	50 μa
HG1008	75	45 mA	20 mA	100 μa
HG1009	75	45 mA	10 mA	50 μa
HG1010	75	45 mA	10 mA	100 μa
HG1011	75	45 mA	5 mA	50 μa
HG1012	75	45 mA	5 mA	100 μa

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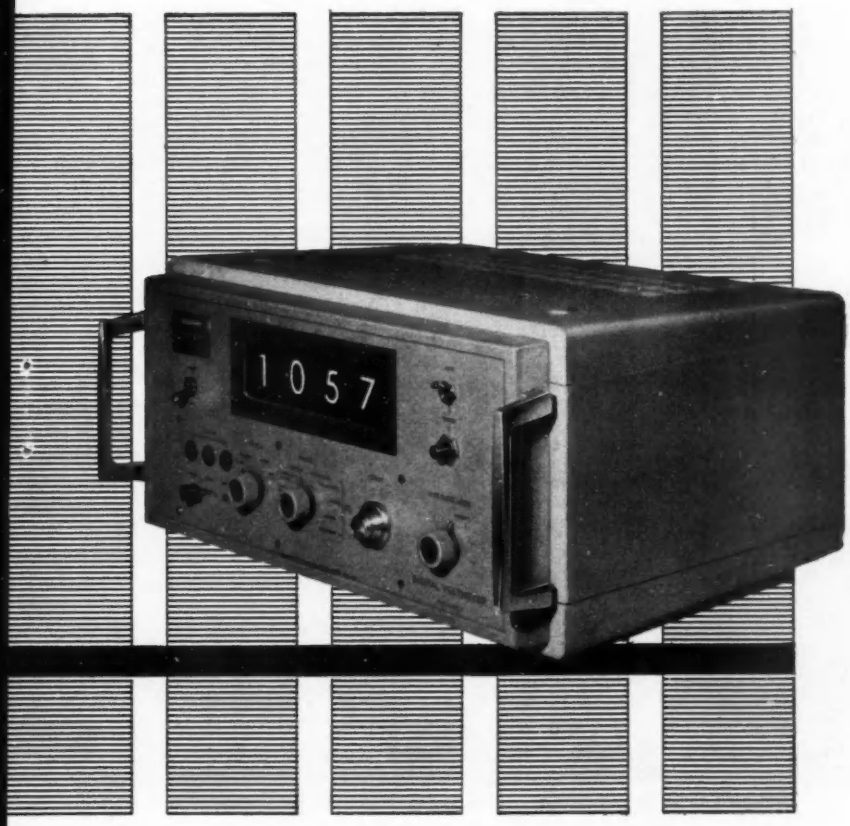

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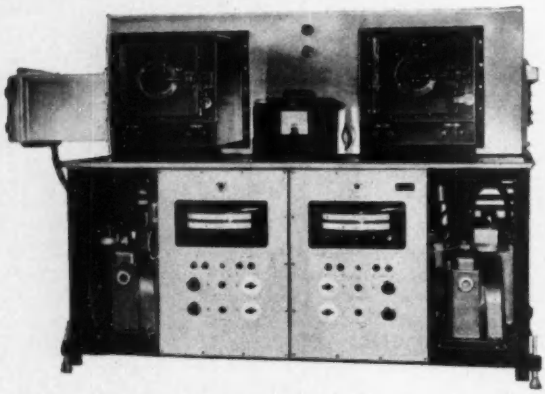

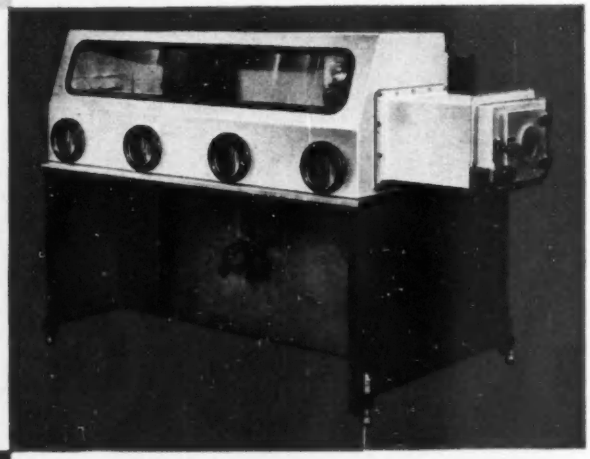

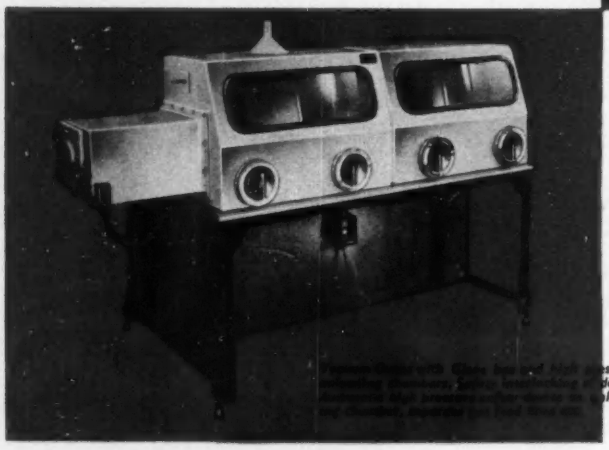

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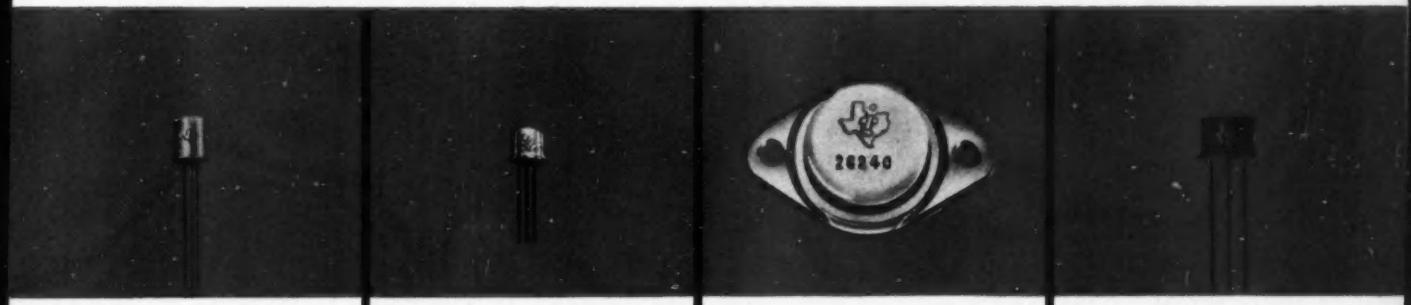

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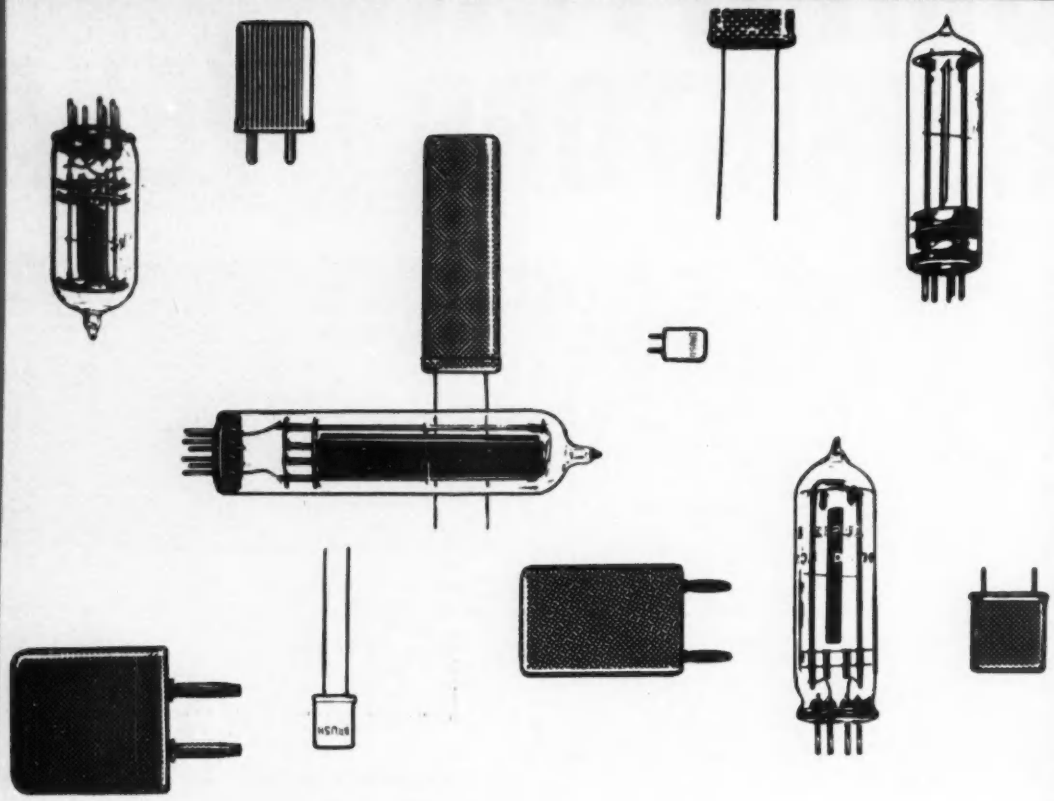

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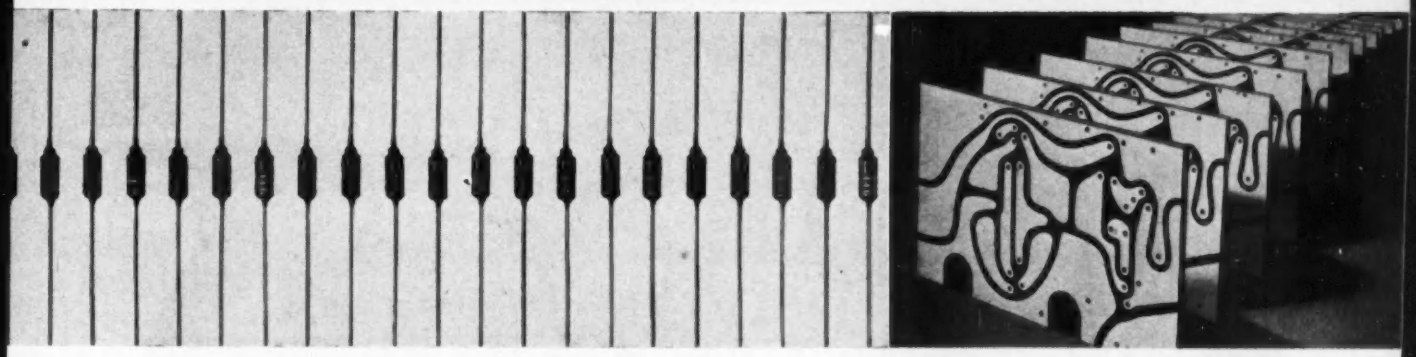

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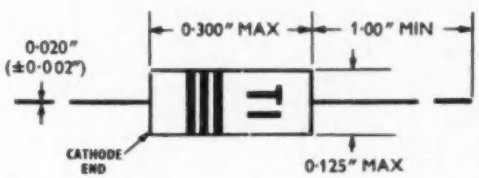
Average Rectified Forward Current at +150°C	I_O	50	50	mA
Recurrent Peak Forward Current at +25°C	$I_{F(pk)}$	2·5	2·5	A
Non-recurrent Surge Current for 1 second at +25°C	i_F	1·5	1·5	A
Non-recurrent Surge Current for 1 second at +150°C	i_F	1	1	A
Operating Temperature, Ambient	T_{amb}	−65°C to +150°C		
Altitude		100,000 ft.		



characteristics

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Max. Reverse Current at P.I.V. at +100°C	I_R	10	10	µA
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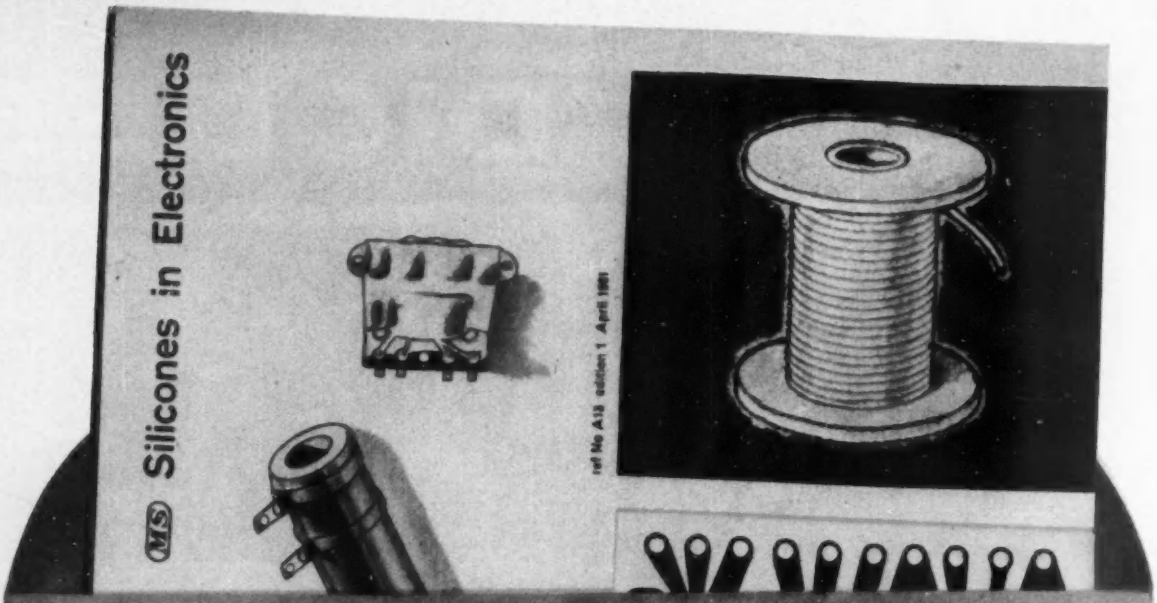

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2S301	High voltage type.	PNP	60	60	200	50	10	40	1·0
2S302	Low gain general purpose transistor.	PNP	25	25	200	50	15	50	1·0
2S303	Medium gain general purpose transistor.	PNP	25	25	200	50	25	75	2·0
2S701	Low gain general purpose transistor.	NPN	25	25	100	20	15	50	8
2S702	Medium gain general purpose transistor.	NPN	25	25	100	20	30	90	12
2S703	High gain general purpose transistor.	NPN	25	25	100	20	60	250	16

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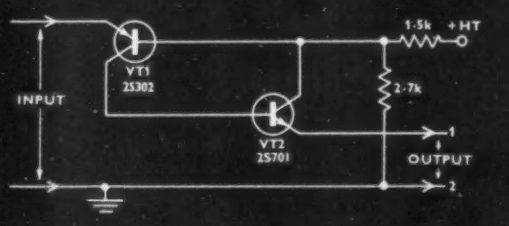

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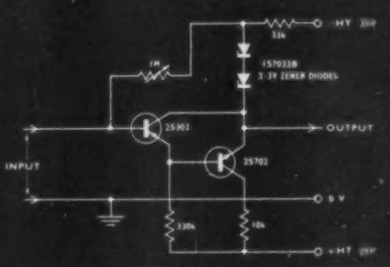

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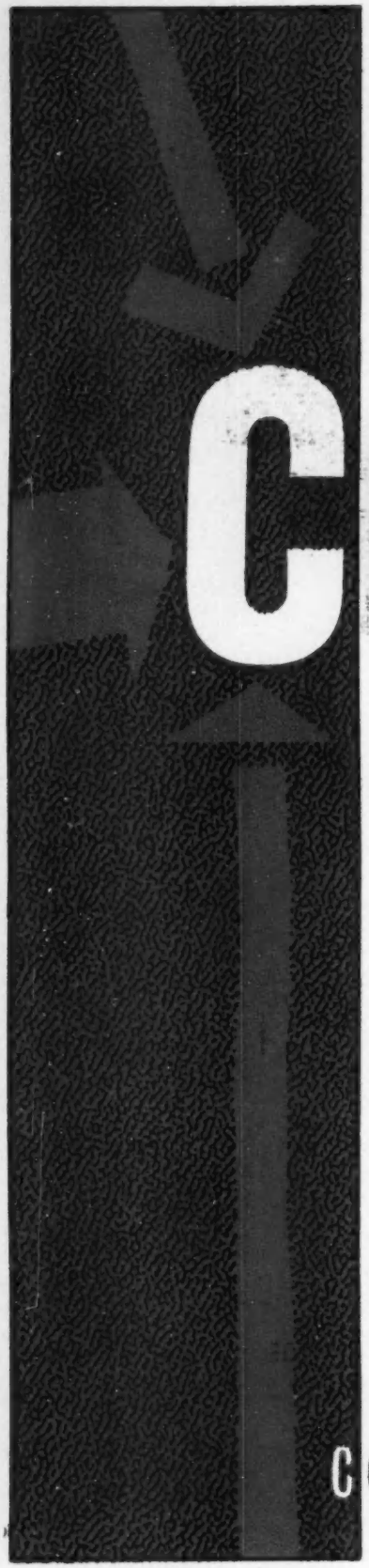

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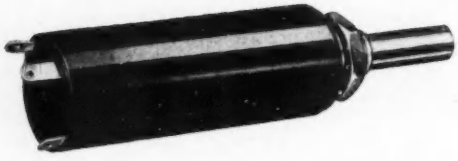

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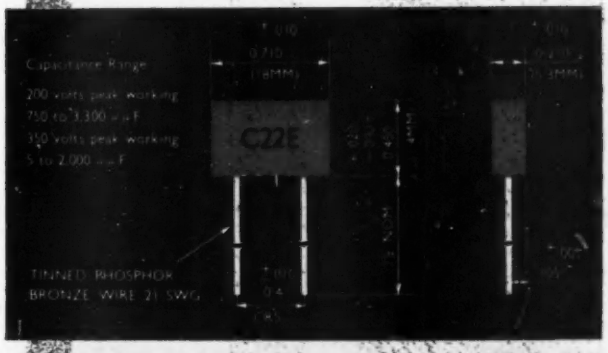

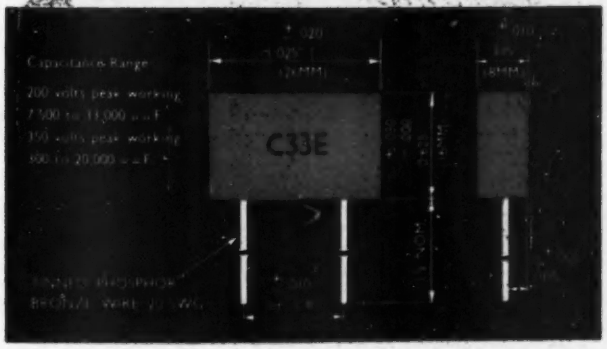

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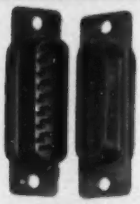

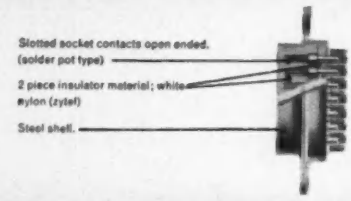

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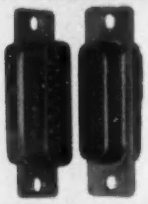

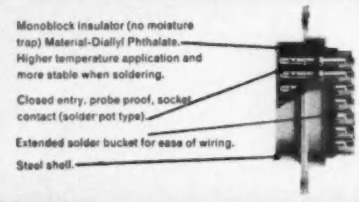
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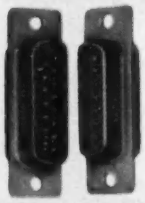
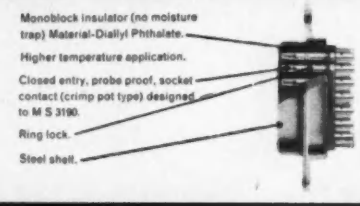
INTERMATEABLE WITH STANDARD CANNON "D"

Also available with snap-in removable coaxial and high voltage contacts. Heavier gauge material (.024) used on the pin insulator shells for greater rigidity.
* Cadmium Plate with gold iridite finish.
* 5 shell sizes with floating mounting bushes if required.
* Insert arrangements with 9, 15, 25, 37 and 50 contacts.
* Junction shells, potting cups and other accessories available.



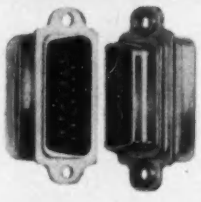

Monoblock insulator (no moisture trap) Material-Diallyl Phthalate.
Higher temperature application.
Closed entry, probe proof, socket contact (crimp pot type) designed to M S 3190.
Ring lock.
Steel shell.

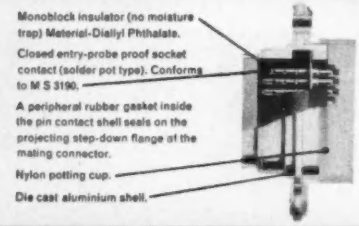
THE CANNON GOLDEN "D" MINIATURE WITH SNAP-IN REMOVABLE CRIMP-TYPE CONTACTS.

SERIES D*SM

INTERMATEABLE WITH D*M AND D* SERIES

Will shortly be available with snap-in removable coaxial and high voltage contacts.
* Cadmium Plate with gold iridite finish.
* 5 shell sizes with floating mounting bushes if required.
Insert arrangements with 9, 15, 25, 37 and 50 contacts.
* Junction shells, potting cups and other accessories available. Heavier gauge metal (.024) used on the pin insulator shells for greater rigidity.

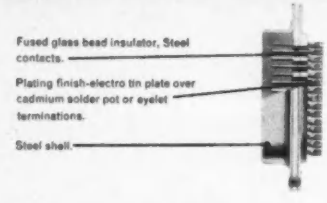



Monoblock insulator (no moisture trap) Material-Diallyl Phthalate.
Closed entry-probe proof socket contact (solder pot type). Conforms to M S 3190.
A peripheral rubber gasket inside the pin contact shell seals on the projecting step-down flange of the mating connector.
Nylon potting cup.
Die cast aluminium shell.

THE CANNON GOLDEN "D" MINIATURE ENVIRONMENTAL CONNECTOR.

SERIES D*D

Will shortly be available with snap-in removable crimp type contacts and removable coaxial high voltage contacts.
* High altitude sealed application peripheral seal permits partial disengagement of ¼" whilst still maintaining seal.
* Insert arrangements with 9, 15, 25, 26, 37 and 50 contacts.
* 6 shell sizes with floating mounting bushes if required.


Fused glass bead insulator, Steel contacts.
Plating finish-electro tin plate over cadmium solder pot or eyelet terminations.
Steel shell.

THE CANNON "D" MINIATURE HERMETICALLY SEALED

SERIES D*H

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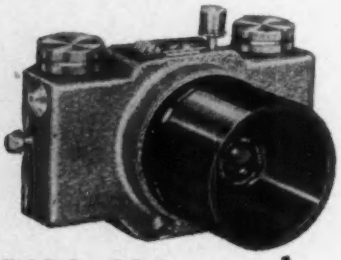
CAMERAS FOR OSCILLOSCOPE AND HIGH-SPEED PHOTOGRAPHY

by JLT



SERIES 105
OSCILLOSCOPE CAMERA

This camera, which is intended for single shot operation, is of simple construction and will produce excellent photographic records. It uses 35 mm. film in standard reloadable cassettes, which hold enough material for 40 exposures. It is supplied with a 2″ focal length lens with a choice of four apertures: f/1, f/1·5, f/1·9, and f/3·5.

SERIES 200
OSCILLOSCOPE CAMERA

Combines the facilities of single shot and continuous feed recording. The motor is housed in a separate unit and connected to the camera by a flexible shaft. All operations are electrically initiated. Standard 35 mm. film (or paper) is used in cassettes containing 50 ft. Film speeds range from 1 in./sec. to 75 in/sec. It is supplied with a 2″ focal length lens with a choice of four apertures: f/1, f/1·5, f/1·9, and f/3·5.

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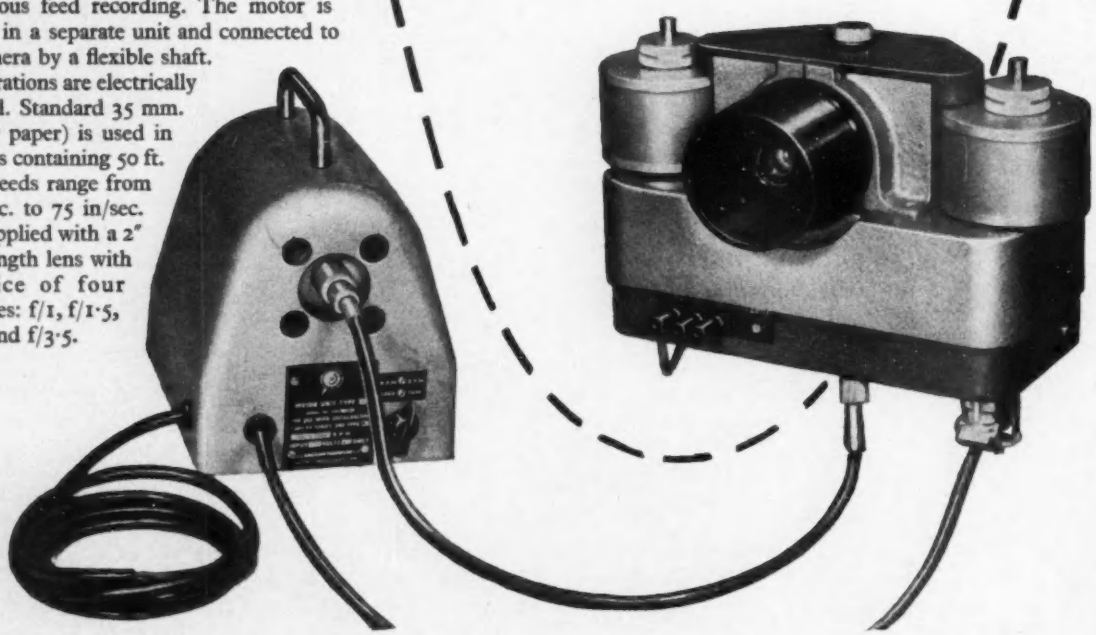

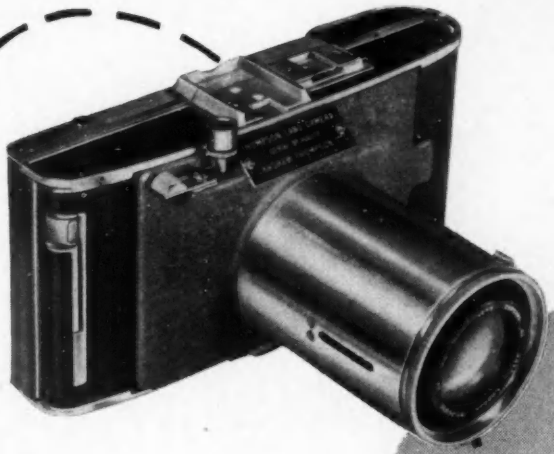

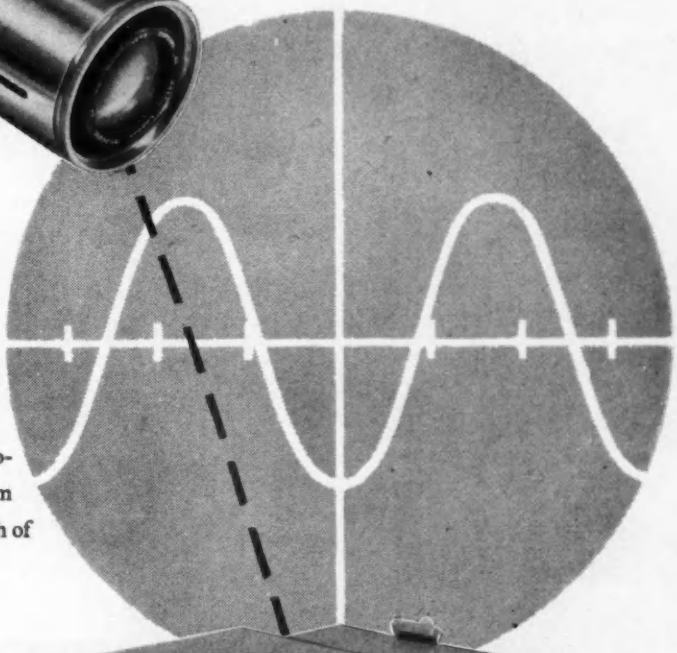

SERIES 405
OSCILLOSCOPE CAMERA

The Thompon-Land single shot camera incorporates a Polaroid-Land Fast Processing Unit, which enables a photographic record to be available in 10 seconds after exposure.
It uses a Polaroid-Land roll film and as all processing takes place inside the camera, no darkroom is necessary. The standard lens has a focal length of 3″, and an aperture of f/1.6.

SERIES 600
RECORDING CAMERA

The Courtney-Pratt High-Speed Camera is of the image sampling type, and will record pictures at taking rates from 1,000 to 150,000 per second. It uses a standard 5″ × 4″ photographic plate on which 300 pictures can be recorded. The effective aperture is f/6·3 and the mechanical shutter has a range of 2 to 19 milliseconds.

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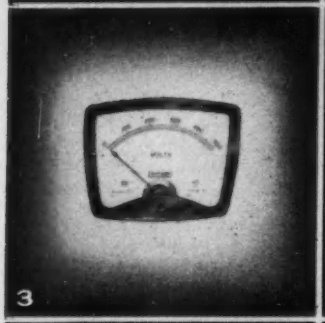
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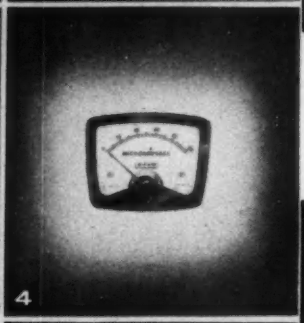
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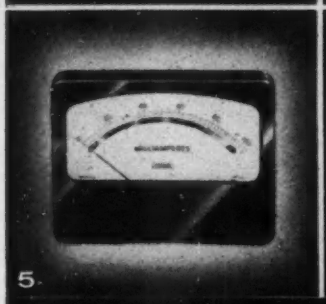
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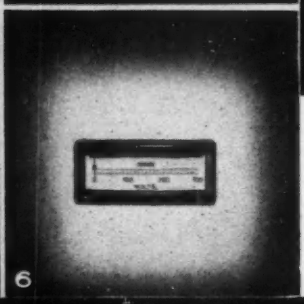
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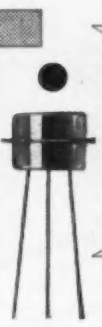

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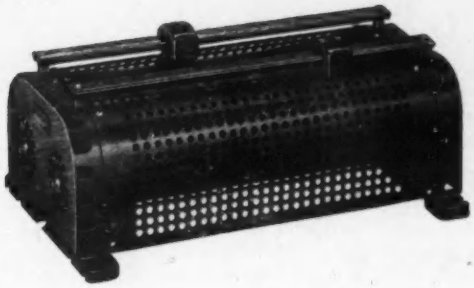
Space limitations preclude us from illustrating our full range, although we hope this current series of advertisements will cover most of the standard productions.



Unfortunately VARIAC transformers, with their compact construction and power rating, cannot be used on D.C. supplies. For these applications ZENITH Rheostats can be usefully employed; we offer a range detailed in Catalogue TR.7. These are wound with copper nickel alloy wire on vitreous enamelled steel tubes, and laminated phosphor bronze brushes maintain positive contact with minimum wear on the winding. Carbon contacts are available as an alternative.
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The versatility of VARIAC continuously-adjustable transformers is evinced by this illustration. Three single phase models "V30H" are mechanically ganged, denoted by suffix "G3", and a set of covers fitted, "M". So model "V30H-G3M" becomes available for connecting to a 415/240 volt, 50 cycle, three-phase supply, and the output may be set at any voltage between zero and 465 volts line to line. A current (rated) of 15 amperes can be drawn at any brush position, but 17.5 amperes (maximum) is available at certain transformation ratios.
Leaflet VAR.6 gives details of this and many other VARIACS.

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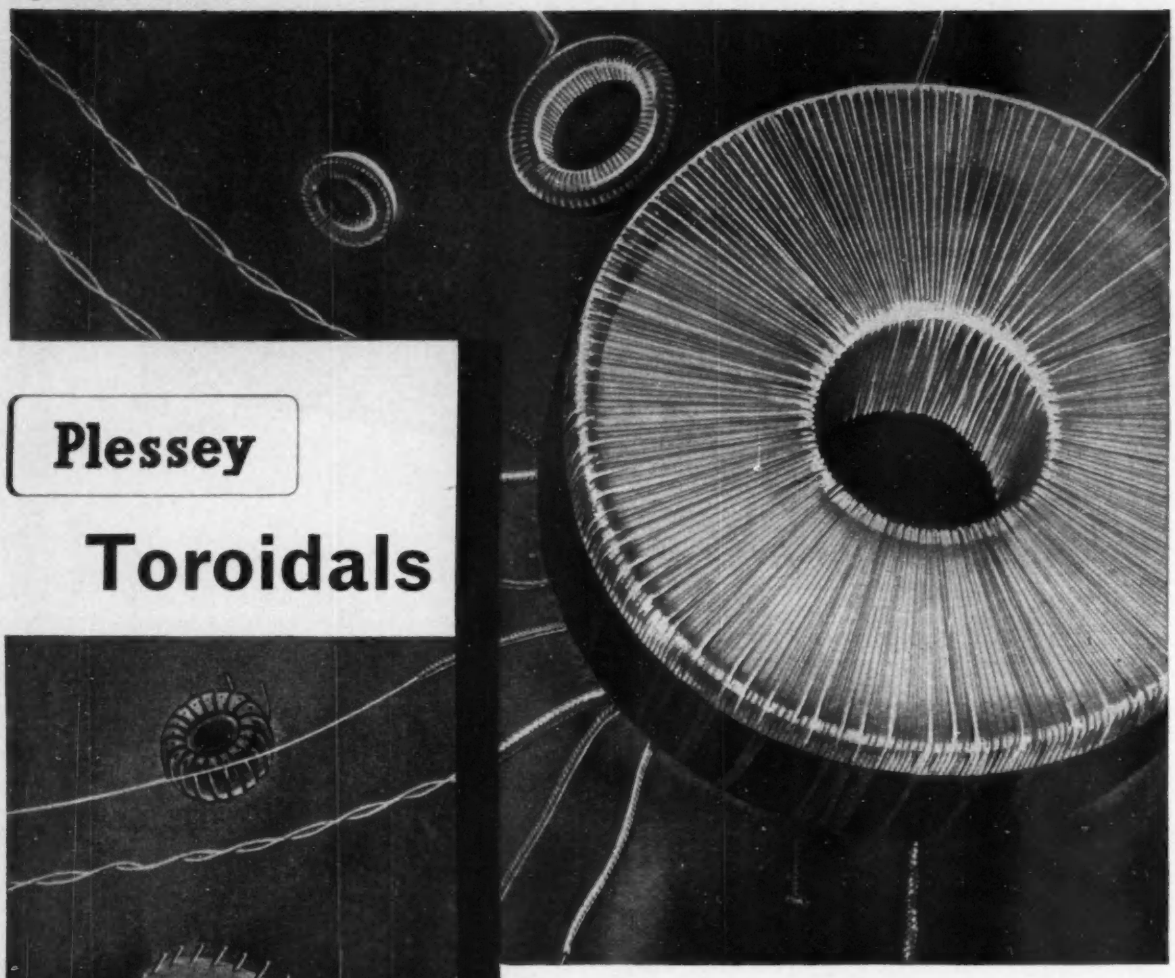
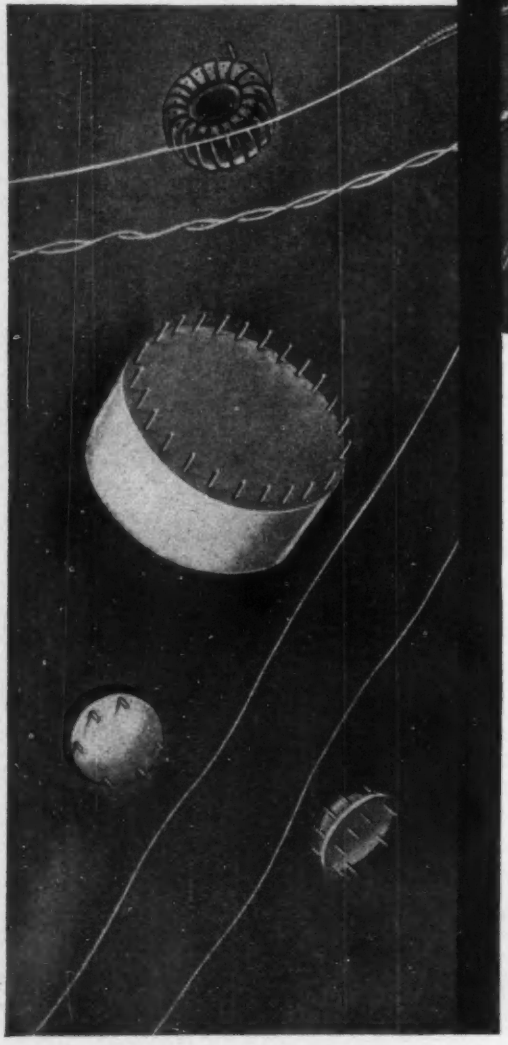


Plessey

Toroidals



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ELECTRONIC ENGINEERING

VOL. 33 No. 402

AUGUST 1961

Commentary

'RADIO Techniques and Space Research' was the subject chosen for this year's Convention of the British Institution of Radio Engineers which was held at Oxford from 5 to 9 July. At the Convention, which was attended by some three-hundred delegates from this country, all parts of the Commonwealth, the U.S.A., and the U.S.S.R., almost fifty papers were presented and discussed. The scope of the Convention was very wide, ranging over satellite launching problems, the whole field of satellite applications, the components necessary for their success and including ground based investigations of the upper atmosphere.

Many of the projects discussed may seem somewhat over-ambitious and very far away in terms of time but there is, however, no doubting the seriousness and enthusiasm with which they are being tackled, not only in the U.S.A. and the U.S.S.R. but also in this country.

In the immediate past, and to some extent at present, the glamour of launching a satellite and the race to put ever larger objects into orbit has tended to cloud the actual use of such feats. Now, however, the time is very rapidly approaching when a payload of several hundred pounds, sufficient for most radio applications, can be placed into a pre-determined orbit with a reasonable degree of surity, and the main task for the next few years is to determine exactly what use can be made of this new-found facility.

Neglecting possible military applications and human space travel, subjects which are far too nebulous and imponderable for speculation, the use of satellites can be very roughly grouped under pure research, navigational aids and as a means of communication.

The bulk of the practical work so far carried out comes under the first heading of pure research and it is also under this heading that the first British contributions will be made; in the first instance in the American launched Scout satellites and later in conjunction with the British Blue Streak based launching vehicle. The scientific applications of satellites are fairly well known and include such subjects as the investigation of the gravitational field of the earth, the structure of the earth's atmosphere and the ionosphere, the magnetic fields near to the earth and in interplanetary space and the zones of trapped radiation such as the Van Allen belt. A considerable number of experiments on these lines have already been made and many more are planned for the immediate future.

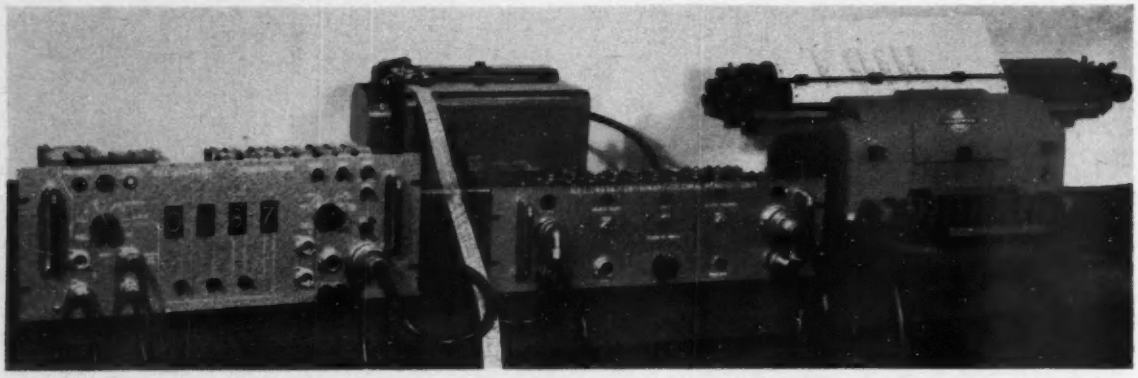
However, from any point of view the satellite is a very expensive form of research and when the glamour and prestige attached to rocket launching have subsided the future of satellites, at least so far as radio is concerned, will depend upon their commercial applications and here their most profitable use appears to be as a media for long distance communication.

At the present time long-distance telephonic communication is carried out by either cable or radio. Both have their advantages and disadvantages. Cable provides reliable communication but a very inflexible system and is generally uneconomic between sparsely populated areas; radio is a more flexible system but by modern standards the typical long distance radio telephone link has a comparatively narrow bandwidth and, in addition, it is generally out of service due to propagation conditions for a considerable proportion of the time. A satellite system could (and perhaps one should underline could) provide a reliable and flexible system together with a wide bandwidth. Whether or not this could be done economically is, indeed, another question, and one which at the moment cannot be answered.

Two types of satellite repeater are possible; the passive and the active. The former consists merely of a large metallized sphere which reflects the signals and, while this is very simple, it entails large tracking aerials and powerful transmitters and it is, consequently unlikely to be an economic proposition. The active satellite on the other hand is equipped with a radio-repeater and as a consequence the ground equipment can be greatly simplified while a greater range and better signal-to-noise ratio can be obtained.

Relaying satellites can be further classified into high orbit and low orbit systems. The high orbit system most generally discussed employs satellites on an equatorial orbit 22 300 miles above the earth. At this altitude the satellite circles round the earth once in 24 hours and thus appears stationary from any point on the earth. With this system continuous coverage can be provided to all inhabited parts of the earth with only three satellites and without using steerable tracking ground aerials. However, the difficulties of establishing such an orbit and of maintaining the satellites in their relative positions are very great. In addition the transit time for radio signals between the earth and the satellite presents another problem. In a low orbit system a considerably greater number of satellites, distributed in a number of different orbits are required for world-wide communications, but the difficulties of establishing the orbits are less severe, as are the effects of one satellite going out of service or of transit time.

From the electronic engineer's point of view perhaps the greatest difficulty inherent in any type of satellite communication system is to design equipment which will operate continuously and reliably without any adjustment or maintenance for long periods in an adverse environment. Indeed, it may well be their ability to do this which will decide whether or not a satellite communication system is economically feasible.



An Automatic Self-Checking Transistor Counter with Digital Display

By H. I. Messer* and W. H. P. Leslie*, B.Sc., M.I.E.E.

An automatic self-checking transistor counter with digital display and provision for a digital read-out has been developed for normal laboratory use, and for use in data-logging systems.

The automatic checks are carried out before the desired count is made, and test the accuracy of the counting circuits, gating circuits, central frequency standard and the display system. Plug-in units are used throughout to simplify fault-finding and maintenance.

(Voir page 546 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 554)

COUNTERS and timers are used extensively at the National Engineering Laboratory and are now being incorporated in digital data-logging systems. Conventional counters have occasionally given false results due to intermittent faults, which were undetected because of the failure of the operator to perform routine checks consistently. As faults are relatively infrequent it is difficult to keep an operator alert to the detection of error. In the case of automatic digital recording systems periodic read-outs may be required from a number of sources under the control of a single operator, in which case regular manual checks become impracticable.

These factors led to the development of a transistor counter/timer, which automatically checks the decade units, gating circuits, divider stages and the accuracy of the central frequency standard which it uses. This is achieved by firstly counting 1kc/s for a duration of 1sec, then checking the resultant count of 1 000 for correctness. The next test is of the units associated with the digital display, and finally of the decade stages which normally provide 10 and 100sec counting periods. These three tests normally occupy 3sec and the counter proceeds with the desired count as determined by the appropriate selector switch settings. Should any test fail the counter remains locked in the 'test' position indicating that the error has occurred. All circuits are assembled as plug-in units, fitting standard 8-way sockets and using miniature plug-in relays. This simplifies fault-finding and maintenance and allows stages to be used in other laboratory designs.

Description of Equipment

Basically there are four commercial transistor counting decades, with relay decoding to operate a decimal display. Gating circuits allow various counting periods to be selected and input circuits permit choice of signals to be counted. Before every reading the counter operation is checked. An external 30V d.c. supply and a source of 1c/s and 1kc/s signals are necessary. The signals are obtained from a central frequency standard[1] or may be derived from a portable quartz-crystal oscillator and a divider if field use is required.

Decade Counters

Counting is performed by four commercial transistor decade counters[2], type TS11, capable of operation up to 30kc/s.

All collector terminals in the TS11 are brought out to pins on the plug-in base, permitting the method described below to be used to display the count.

Resetting to zero is achieved by momentarily breaking the connexion between earth and the common point of the base bias resistors from the 'even' transistors, causing all these transistors to be switched 'on', thereby taking up the zero configuration. Similarly, resetting to 9 is achieved by momentarily breaking the connexion between earth and the common point of the 'odd' transistor base resistors.

Display

Four in-line indicators, type KMG, display the count by the following method. Each decade unit employs four relays to record its binary condition. These relays are energized via four transistor buffer stages, see Fig. 1, which are individually connected to each 'even' collector on the decades. The contacts of these four relays are wired in the form of a binary to decimal 'tree' with the

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The above illustration shows the counter and read-out unit with ancillary equipment.

ten outputs connected to their appropriate numeral lamps on the in-line indicator. These display the appropriate state of the decades. A total of sixteen relays and sixteen buffer stages are required to display a four-digit number.

The counter buffer stage, Fig. 1, comprises an emitter-follower VT_3, employing an OC73, and a grounded emitter OC77 transistor to operate the relay. The voltages available at the decade collectors are -8V (off) and $-2{\cdot}5$V (on). Fixing the emitter supply of the two transistors at -5V results in VT_1 being cut-off when the potential at pin 6 falls to $-2{\cdot}5$V, and being brought into conduction when pin 6 rises to -8V. The rise in emitter potential to approximately 1·5V switches VT_2 on. The two transistors are necessary to provide sufficient current gain.

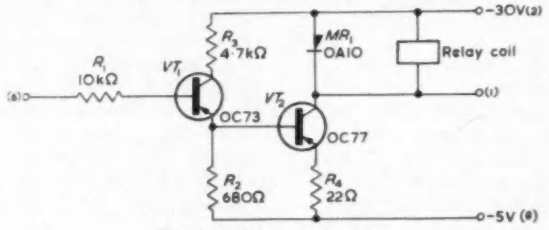


Fig. 1. Transistor buffer stage

The effective resistance of R_2 is less than the nominal value as it is appreciably reduced by the shunting action of VT_2.

The diode MR_1, shunting the relay coil, prevents the back e.m.f. rising above the supply voltage when the relay de-energizes, protecting transistor VT_2 against excessive voltages. A normally open contact from each relay is taken to an output socket which can be connected to an external read-out unit when the count has to be recorded on a typewriter or punched paper tape. The 'read-out' will be described elsewhere[3].

Input

Two separate input connexions are available. *A* carries the incoming waveform to be counted and *Z* carries the standard pulses at frequencies of 1c/s and 1kc/s derived from the central frequency standard.

INPUT *A*

Input *A* is taken via the select count switch to a pulse shaper and amplifier, Fig. 2. This unit is foolproof and adaptable, being designed to operate from the following waveforms:

(1) Sinusoidal, 0 to 30kc/s, minimum input IV peak-to-peak.

(2) Negative pulses, minimum input IV.

(3) Positive, minimum input IV, and will not be damaged by a 240V input.

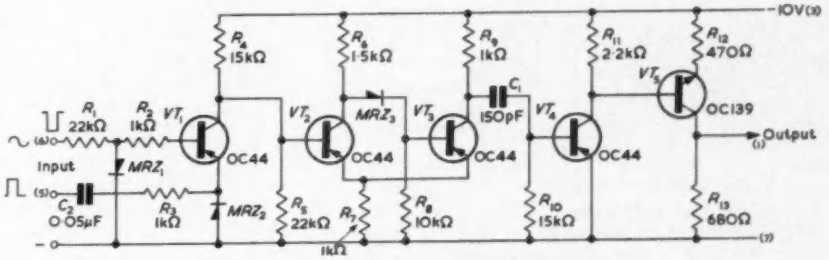
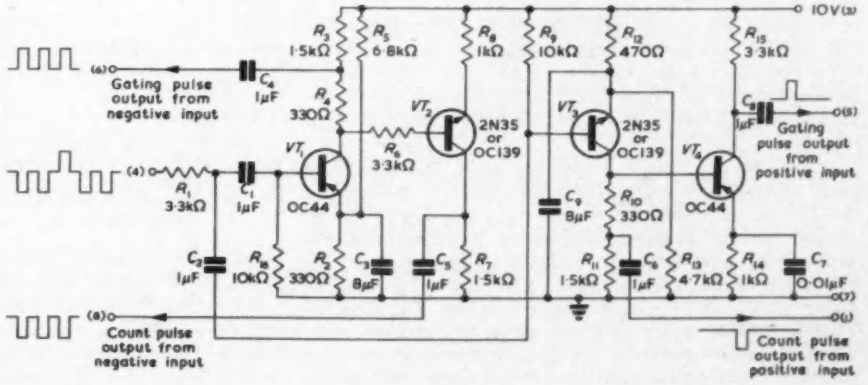


Fig. 2. Pulse shaper and amplifier

It has a high discrimination of signal to spurious high-frequency noise, achieved by incorporating a Schmitt circuit, VT_2 and VT_3, having the property of 'backlash' so that the voltage has to decrease well below the turn-on voltage to turn the stage off again. The Zener diode MRZ_3 has the advantage over the resistor normally used, of providing the required voltage drop (-5V) when VT_2 is held off, while its low dynamic resistance permits the provision of adequate base current to turn VT_3 on, thus easing a design restriction. The amplifying stage driving the Schmitt circuit has the sinusoidal or negative input d.c. coupled into the base of VT_1 via a series 22kΩ vitreous resistor R_1 and a shunt 5V Zener diode MRZ_1. This d.c. coupling permits operation for very low frequency sine waves. The positive peak of a sine wave is limited at ~0·5V by MRZ_1 conducting in the forward direction and the negative peak is similarly limited at -5V by the 'breakdown' action of this diode. The 22kΩ vitreous resistor prevents excessive input voltages (e.g., 240V r.m.s.) from damaging the amplifier, the resistor having a sufficient power rating, while the Zener diode limits the voltage applied to the amplifier proper. The positive input is a.c. coupled, through C_2 and R_3 into the emitter of VT_1, and the maximum input is restricted to 5V by the 'breakdown' action of MRZ_2. The 1kΩ resistor R_2, in series with the base, limits the emitter current to a safe value of 5mA when maximum input voltage is present on the emitter. The potential at the junction of R_4 and R_5 requires to be $-4{\cdot}2$V to turn VT_2 'on' and $-2{\cdot}4$V to turn it 'off'. The negative-going output from the collector of VT_3 is differentiated by C_3 and R_{10}. The negative pulse turns the amplifier stage VT_4 'on' which then turns on the npn transistor VT_5. This gives a low impedance drive for the negative output pulse capable of supplying all four decades in parallel during maintenance testing.

Fig. 3. Pulse separator


Gating pulse output from negative input
Count pulse output from negative input
Gating pulse output from positive input
Count pulse output from positive input
2N35 or OC139
OC44
10V(3)

INPUT Z

The input Z carries both the standard negative 1kc/s 'count' pulses and the positive 1c/s 'gate' pulses[1]. The two pulse trains are separated by transistors VT_1 and VT_3 in Fig. 3. The pnp stage VT_1 conducts on the negative 1kc/s count pulses and npn stage VT_2 conducts on the positive 1c/s gate pulses. Both transistors have their emitters biased in the non-conducting direction to prevent hum, noise or overshoot from being allowed through the stages. Positive 1kc/s pulses are available at the junction R_2R_4 for subsequent division to produce 10c/s gate pulses. The collector of VT_1 is d.c. coupled via R_6 to the base of the pulse inverting npn amplifying stage VT_2, from the collector of which negative 1kc/s pulses are derived.

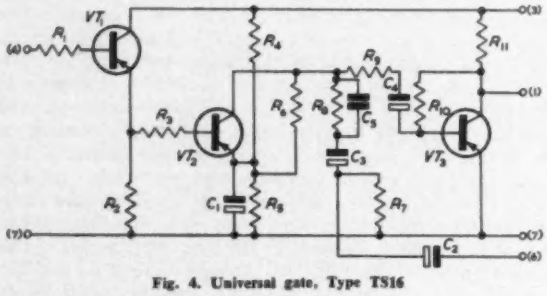


Fig. 4. Universal gate, Type TS16

Negative pulses of 1c/s are available at the junction of R_{10} and R_{11}. The collector of VT_3 is d.c. coupled to the base of the pulse inverting pnp amplifying stage VT_4 and positive 1c/s pulses are obtained from its collector.

Gating Circuits

The gating circuits determine the duration of the counting period.

GATING UNITS

The gating is performed by two commercial binary stages, type TS2B, and a gating unit TS16, connected as recommended by the manufacturer[4]. When a voltage of −5V is applied to pin 4 of the gating unit TS16 in Fig. 4 count pulses are passed from pin 6 to appear at the output pin 1. When the voltage applied to pin 4 rises to −8V no pulses appear at the output. The two voltage levels required to 'open' and 'close' the gate are obtained from the output (pin 2) of the binary stage, TS2B-2, Fig. 5.

When the two binary stages are reset, the output at pin 2 of TS2B-2 is at approximately −8V and thus causes the gate to be closed. The start pulse arriving at pin 4, TS2B-1, reverses the condition of the two binary stages, causing the level at pin 2, TS2B-2, to change to −5V, which allows the gate to open. The next stop pulse to arrive at pin 6 of TS2B-2 again changes the state of TS2B-2, thereby returning the potential at pin 2 to −8V, which closes the gate. In this state further start and stop pulses are ineffective, and the binary stages will remain

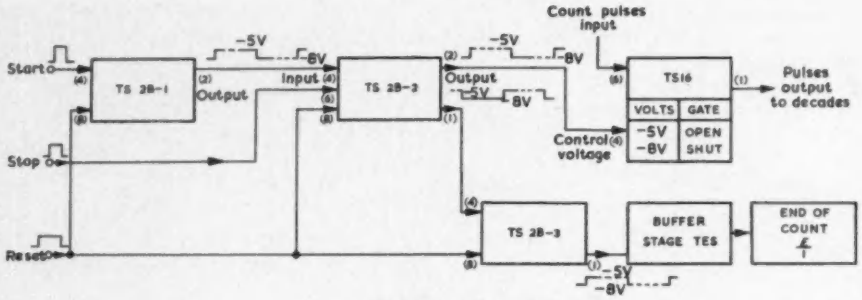


Fig. 5. Gate and latching circuit

in this condition until reset. The method of resetting the binary stage is similar to that used for the decade units TS11, via relay contact RR_3.

END OF COUNTING PERIOD

For the correct operation of the control circuits (described below) it is necessary to indicate the end of each 'count' by energizing a relay $E/1$. This requires an extra binary stage TS2B-3, Fig. 5, which is triggered by the binary stage TS2B-2 when it initiates the closing of the gate. In this case it is necessary to take the connexion from pin 1 of TS2B-2, which provides a positive going output when the stop pulse changes the state of TS2B-2. When TS2B-3 is triggered, relay $E/1$ is energized via the buffer stage TES, which is identical to Fig. 1. When TS2B-3 is reset, $E/1$ is de-energized.

GATING PULSES

The external gating pulses at 1sec intervals are available from the pulse separator. Additional pulses separated by 0·1, 10 and 100sec intervals are obtained by employing two TS11 decades in cascade, Fig. 6. Both units are reset to 9 before being used. The 1sec pulse reaching them resets both to zero, making available a 10sec or 100sec start pulse in the minimum of time. 10 or 100sec later a second pulse is generated in a similar manner to act as a stop pulse. Similarly, pulses at intervals of 0·1sec are obtained by energizing a relay $FF/4$ whose contacts (Fig. 8) select positive 1kc/s pulses instead of the normal 1c/s pulses. When divided by 100, as before, a pair of 10c/s pulses is produced which provides the 0·1sec interval at the gate. External gate pulses can be applied via *B* and *C*. The seven positions of the select gate switch enable selection of: internal 0·1, 1, 10 and 100sec intervals, start *B*-stop *B*, start *B*-stop *C* and manual. In the latter case the start/stop push-buttons are used and the counter is effective from the instant the start button is pushed until the stop button is pushed; the 1sec gating pulses are not used. This is provided as a testing facility and can also be used to prepare the counter to receive a number of pulses which have to be counted.

Checking Circuits

The following conditions are tested in sequence as described in the section on control of the counter:

(a) Set and check zero
(b) Input 1kc/s for 1sec and check 1 000
(c) Set 9999 and check
(d) Check most and least significant decades against the two divide by ten stages—test for 0010 at end of count.

CHECK 1 000 COUNTS

Fig. 7 shows a four diode coincidence gate connected

to a common emitter transistor operating a relay. The diode anodes are connected to the four lamps used to display a count of 1 000 as indicated in Fig. 6. When all four lamps are on simultaneously the diodes will be cut off, allowing transistor VT_2 to conduct and thence energizing relay $C/2$ due to the negative bias applied to the base of VT_2 through R_1 and R_2 in series. In all other cases when one or more of the four lamps are not energized, the d.c. path to earth through the lamp filament will allow the associated diode to conduct, so reducing the potential at the junction, R_1R_2, to approximately -1V. This drop in potential with the emitter supply held at -5V will hold VT_2 well below cut-off, preventing $C/2$ energizing. The cold resistance of the lamp filament is of the order of 50Ω. As a precaution in the event of an open-circuited filament, a 560Ω resistor is shunted across each of these four lamps to maintain a d.c. path to earth.

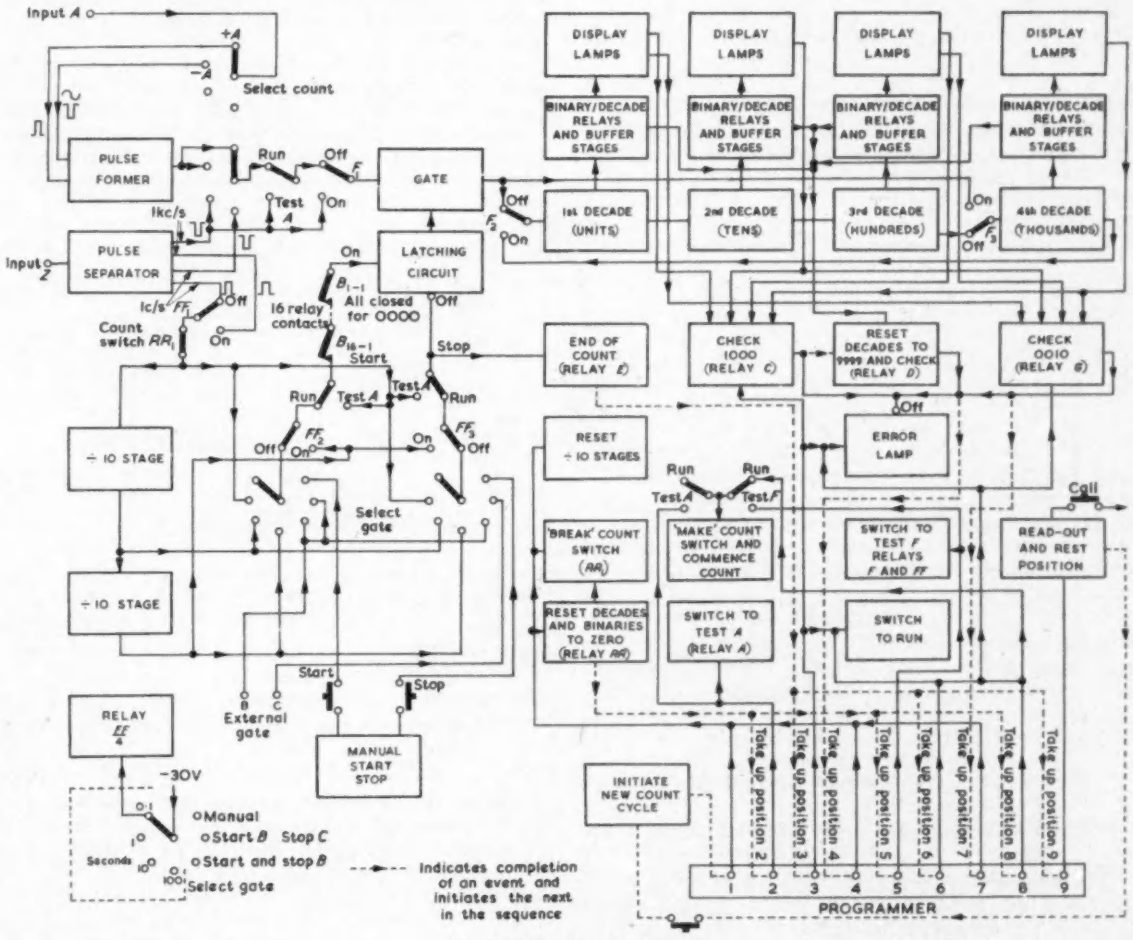


Fig. 6. Block schematic diagram

Check Reset 9999

A feature of the TS11 decades as used, is that when reset to 9, their binary condition causes all sixteen relays to be energized via their buffer stages. In this condition normally open contacts on each relay connected in series provide a d.c. patch which is broken in the event of any relay failing to be energized, see Fig. 8.

Check Divider Stages

The previous tests do not check the operation of the two decades normally used as dividers to produce the trains of pulses separated by 0·1, 10 and 100sec intervals for gating the counter. Also the most significant decade of the counter has only been asked to count to 1 (a total count of 1 000 in four decades).

During this test the relay contacts in Fig. 6 arrange for the 1kc/s signal to enter the counter at the 'thousands' decade and proceed from there to the units, tens and hundreds decades. The test contacts also arrange for the 1kc/s signal to proceed to the two dividers and emerge as a pulse every 0·1sec. These pulses are used to gate the 1kc/s signals into the counter (arranged as above) for 0·1sec. When both function correctly 100 counts are obtained—these are displayed as 0010 because of the rearrangement of the counting decades. This count of 0010 is checked by a coincidence gate similar to Fig. 7.

Control of Counter

Scanning and Timing

A miniature plug-in 12-position uniselector is used to control the sequence of events occurring during one complete operation of the counter.

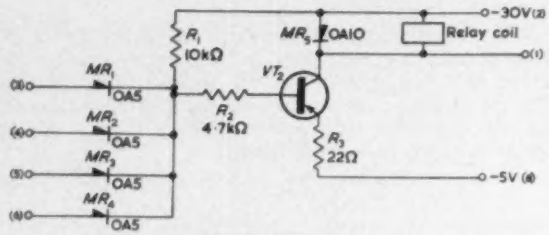


Fig. 7. Check '1 000' stage

All three available banks are utilized as follows:

Bank 1—which has a make-before-break wiper arm, is used to reset the uniselector to its normal starting position.

Bank 2—steps the uniselector on after the completion of each event.

Bank 3—initiates the events occurring during operation.

The sequence of events occurring during one complete operation are listed in Table 1 and a detailed account given in the description of operation. 3sec are used for this test.

Description of Operation

Move to position 1

On pressing the reset button, Fig. 8, the relay $R/3$ is energized. Contact R_1 closes and holds the relay energized; R_2 closes and energizes the uniselector $US12/3$ through its normally closed contact $US12$-1.

Immediately $US12/3$ operates, contact $US12$-1 opens and de-energizes $US12/3$. This action steps the uniselector from whatever position it is at to position 1 in a series of rapid steps. While $R/3$ was energized, the normally closed contact R_3 broke the supply to uniselector arm 3, preventing relay $RR/3$ from being energized prematurely.

When the uniselector reaches position 1 relay $R/3$ is released breaking the supply to $US12/3$ to stop it and contact R_3 closes applying voltage via the uniselector arm 3 to $RR/3$, a remanent relay. Contact RR_1 opens preventing pulses from reaching the 'gate'. Contact RR_2 opens resetting the counting decades to zero, the other decades to 9 and the binary units to 0. Contact RR_2 closes energizing $US12/3$ via $US12$-1 causing the uniselector to move to position 2.

Position 2 count 1 000 c/s for 1 second

In position 2, relay $A/4$ is operated. Contacts A_1, A_2 and A_3, take up the 'test' position breaking the normal count and gate circuits. In the test position 'count' pulses of 1kc/s are selected by A_1, and 'start and stop' pulses of 1c/s by contacts A_2 and A_3. A_4 closes and resets relay $RR/3$; contact RR_3 closes and restores the connexion between earth and the various reset points; contact RR_2 opens and contact RR_1 closes permitting the next 1sec pulse to 'open' the gate and commence the test count providing the sixteen contacts in series with the 'start' line are closed, ensuring that the counter is at

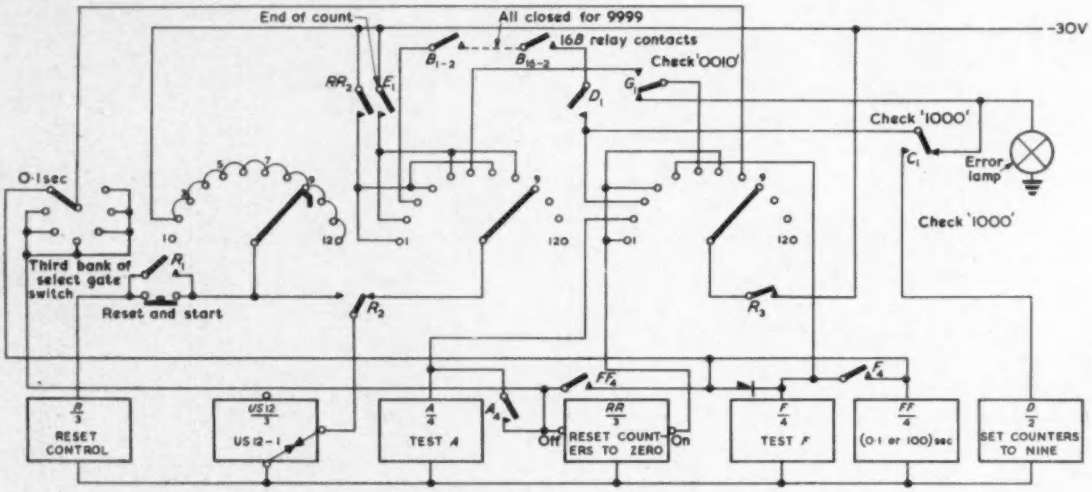


Fig. 8. Scanning and control circuits

TABLE 1

POSITION	FUNCTION
1	Reset to zero (A) Correct ↓ Wrong → Stop
2	Start 1000 Count test run
3	At end of test run check 1000 Correct ↓ Wrong → Stop indicate error Set 9999
	Check 9999 Yes ↓ No → Stop indicate error
4	Reset zero (B) Correct ↓ Wrong → Stop
5	Start 100 count
6	At end of test run check 0010 Correct ↓ Wrong → Stop indicate error
7	Reset zero (C) Correct ↓ Wrong → Stop
8	Start normal test run
9	At end of run display count and wait

zero. The following 1sec pulse 'closes' the gate causing the 'end of count' relay $E/1$ to be energized as previously described. With relay $E/1$ energized, contact E_1 closes and steps the uniselector to position 3, thereby releasing relay A and causing contacts A_1, A_2 and A_3 to revert to their normal positions.

Position 3 check 1 000 and 9 999

The count of 1 000 is checked as described above. If correct, a relay $C/2$ is energized and changeover contact C_1, in Fig. 8, switches over and energizes relay $D/2$. Contacts D_1 and D_2 open, resetting the counting decades to 9. This causes relay $C/2$ to be de-energized (the count at the coincidence gate is no longer 1 000); contact C_1 thus releases relay $D/2$ closing D_1 and D_2.

In this condition the sixteen relays which are used for 9 999 should be energized as described previously. Thus, contact D_1 closing completes the circuit through the sixteen contacts applying a voltage from arm 3 of the uniselector to contact 3 of bank 2, Fig. 8. $US12/3$ will then be energized and released to take up position 4. Should

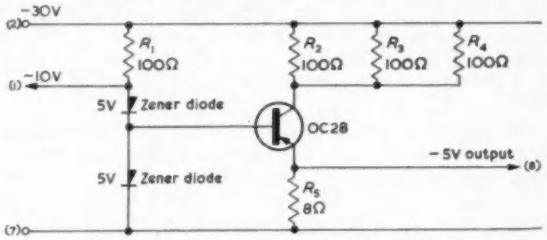


Fig. 9. Emitter-follower and −10V supply

either (a) the count of 1 000 not be obtained or (b) the reset 9 999 test fail, the red 'error' lamp will be energized and the uniselector will remain in position 3.

Position 4 reset 0000

In position 4 relay $RR/3$ is again energized, repeating the resetting procedure as at position 1. The decades, binary units and relay $E/1$ are reset and $US12/3$ moved to position 5.

Position 5 count to 0010

In position 5 relay $F/4$ is energized and contact F_3 in Fig. 6, changes over, directing the 1kc/s count pulses to the input of D_4 when the gate is open. Contact F_2, changing over, directs the output from D_4 to the input of D_1 while contact F_1 applies 1kc/s pulses to the gate. Contact F_4 closing (Fig. 8) energizes relay $FF/4$, in Fig. 6, where contact FF_1 selects positive pulses of 1kc/s to be fed to the two divide by 10 stages to produce gate pulses at 10c/s. Contacts FF_2, FF_3, switch over, ready to apply start and stop pulses of 10c/s to the gate binary. Contact FF_4, in Fig. 8, closes and releases $RR/3$, completing the resetting operation. The 1kc/s is counted for 0·1sec and displayed as 0010. The 'end of count' relay $E/1$ will be energized on completion of the count and E_1 closing moves $US/1$ to position 6.

Position 6 check 0010

Relays $F/4$ and $FF/4$, in Fig. 8, release. The count of 0010 is checked and if correct relay $G/1$ will be energized via the 0010 coincidence gate. Contact G_1 switching over applies a voltage from arm 3 of $US12/3$ to pin 6, bank 2. $US12/3$ will then be energized to move to position 7.

Position 7 reset 0000

The reset to zero procedure of positions 1 and 4 is repeated and the uniselector takes up position 8.

Position 8 start normal count

Relay $RR/3$, in Fig. 8, is now released. The count is now determined by the 'select count' and 'select gate' settings as described earlier. On completion of the count the 'end of count' relay $E/1$ will be energized moving $US12/3$ to position 9.

Position 9 read position

The counter is now in the rest and read-out position. From this position a signal is sent to the 'read-out' unit associated with the counter to indicate that it is in a state of readiness to be 'called'.

D.C. Supplies

The counter requires a 30V d.c. external supply. Two 5V Zener diodes in series provide a stable −10V supply to the commercial stages used, as shown in Fig. 9. The −5V required to supply the 'buffer' stages is derived from an emitter-follower also shown in Fig. 9. The emitter-follower, employing an OC28, is designed to pass a standing current of 700mA. When any buffer stage is called the load appears across the emitter and the −30V line which reduces the current being drawn from the transistor. Five-watt vitreous resistors were used throughout to handle the large power dissipation.

This stage was also assembled as a plug-in unit which was specially designed to dissipate the large amount of heat produced.

Application

The equipment is designed for use both as an industrial and a laboratory instrument. It is suitable for use as a normal counter for frequencies up to 30kc/s and can be adapted, when used in conjunction with its 'read-out' unit, for use in data-logging systems where the results are required in a form suitable for recording on a typewriter and/or paper tape punch.

The use of standard units of a similar type for different applications wherever possible has resulted in a large degree of interchangeability and considerably reduces the number of spares required. Unit replacement also permits rapid servicing as a faulty stage can be examined in detail under less pressing circumstances.

Conclusion

The equipment described has been developed and subjected to continuous self-checking operation for two 10-hour periods, equivalent of several months usage under normal conditions, without any signs of faulty operation. A group of these counters has been in use in the laboratory for six months. The self-checking features have already restrained enthusiastic experimenters from continuing to log results when an intermittent fault was developing.

Acknowledgments

The authors wish to acknowledge assistance given by Messrs. A. Russell and J. J. Hunter and permission given by Messrs. Venner Electronics Ltd to publish Fig. 4.

The work described was carried out in the National Engineering Laboratory, East Kilbride (Department of Scientific and Industrial Research) and the article is published with the permission of the Director, Dr. Sopwith.

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SECONDARY SURVEILLANCE RADAR

By D. H. R. Archer*, M.A.

(Part 2)

(Voir page 473 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 481)

Detection Probability

The probability of receiving any number of defruited responses to a single illumination is a function of the number of interrogations per illumination period and of the probability that the transponder will reply to a single interrogation—which in turn is dependent upon a number of factors, some of which are discussed below. In Table 1 (which has been prepared on the somewhat erroneous, but qualitatively adequate, assumption that each interrogation of a transponder can be regarded as independent of all other interrogations and as having a constant probability of success) are shown the probabilities of obtaining from one or more to five or more defruited responses to a single illumination containing ten interrogations, when the probabilities that the transponder will reply to a single interrogation are 0·4, 0·6 and 0·8.

In Table 2 are shown the results of a similar calculation with respect to double defruiting.

It will be observed that double defruiting substantially reduces the detection probability even when the probability of reply to a single interrogation is as high as 80 per cent. It is not surprising, therefore, that Ashley and Battle[6] should have commented that double defruiting may degrade performance.

Mode Interlace

It may be objected that the number of interrogations per illumination period chosen for the above tabulation is unrealistically low. It is indeed true that in a practical system the number may be nearer twenty than ten: with a beamwith of 3° and a recurrence frequency of 400 interrogations/second—consistent with a maximum range of some 200 nautical miles—10 pulses per beamwidth corresponds to an aerial rotation rate of 20 rev/min, whereas a rotation rate of 10 rev/min or even less might be regarded as more reasonable.

There is, however, a technique of employing secondary surveillance radar in which more than one mode of interrogation is used. This technique is called ' mode interlace ', and its purpose is to use the system to extract more information from a transponder during a single illumination period than can be obtained by using a single interrogation mode: it can also be used to interrogate aircraft selectively—e.g. to distinguish between civil and military aircraft by causing their transponders to be set to reply to different modes and interrogating sequentially with these modes. The introduction of such a technique modifies the defruiting requirements: instead of comparing replies to successive interrogations the defruiter must compare the replies to interrogations 1 and 3, 2 and 4 etc., if two-mode interlace is used, or 1 and 4, 2 and 5, 3 and 6 etc., if three-mode interlace is used and so on. Table 1, therefore, also shows the probabilities for two-mode interlace with a total of twenty interrogations per illumination period or with thirty interrogations for three-mode interlace and so on.

With an aerial rotation rate of 10 rev/min and a beamwidth, as above, of 3° an interrogation rate of 400 interrogations/second will give twenty interrogations per illumination. With four-mode interlace—the largest yet proposed—this gives five interrogations/mode/illumination. What this means in terms of detection probability is shown in Table 3.

Compatibility With Primary Radar

From Table 3 it is apparent that mode interlace is a luxury to be employed sparingly if the system is to be used for surveillance purposes with a fairly high data renewal rate. Nor, indeed, is mode interlace the only reason why the number of interrogations per illumination period may have to be lower than the optimum value. It is expected that secondary radar interrogator-responsors will commonly be associated with primary surveillance radars —especially while, as there will be for some years, there are aircraft to be controlled which do not carry transponders. In many cases economic considerations may make it necessary that primary and secondary radar information be displayed on the same ' raw ' visual display: this is not the best way of associating the two—the best way is to keep them totally separate up to and including the raw displays and then synthesize the information with a sophisticated processed display system—but it may well be the most sensible. To effect the association in this simple way it will be necessary to synchronize the aerial rotation rates and interrogation repetition rates: it will also almost certainly be necessary to sacrifice some of the raw primary radar information to accommodate that from the secondary radar; so that any synchronization sacrifices required are likely to have to be made by the secondary radar.

The secondary radar interrogation rate cannot be made

TABLE 1

Defruited replies to 10 successive interrogations	Detection probability, if probability, p, that transponder will reply to a single interrogation is 0·4	0·6	0·8
One or more	0·709	0·947	0·998
Two or more	0·408	0·805	0·985
Three or more	0·196	0·624	0·950
Four or more	0·080	0·417	0·868
Five or more	0·029	0·245	0·747

TABLE 2

Double defruited replies to 10 interrogations	Detection probability if p is 0·4	0·6	0·8
One or more	0·314	0·699	0·956
Three or more	0·047	0·278	0·736
Five or more	0·005	0·078	0·349

TABLE 3

Defruited replies resulting from five successive interrogations	Detection probability for p= 0·4	0·6	0·8	0·9
One or more ..	0·433	0·740	0·942	0·987
Two or more ..	0·095	0·441	0·799	0·940
Three or more ..	0·041	0·181	0·492	0·722
Four	0·010	0·078	0·328	0·590

* *Cossor Radar and Electronics Ltd.*

very high because of the danger of 'second time round' responses—responses to an interrogation preceding that to which they appear to relate*—so that if the primary radar p.r.f. is greater than the optimum secondary recurrence frequency but less than twice that frequency the secondary recurrence frequency may have to be reduced. In many such cases the primary radar aerial rotation rate will also be on the high side and the secondary radar will have to follow suit. It will not be uncommon, therefore, especially in the smaller air traffic control organizations, to find a secondary radar interrogator giving a total number of interrogations per illumination period not much in excess of ten: under these conditions even two-mode interlace will create a situation similar to that hypothecated in Table 3 and four-mode interlace, with defruiting, is unlikely to result in any displayed responses at all.

The Ground Aerial

The importance of achieving a high probability that the transponder will reply to a single interrogation is evident from Tables 1 to 3. One important factor in the determination of this probability is the vertical polar pattern of the

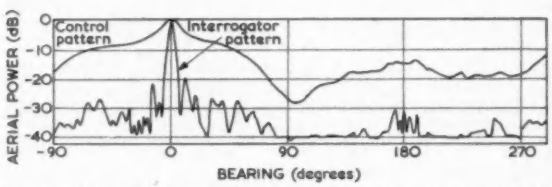

Fig. 4. Combined aerial radiation diagram for ICAO two-pulse sidelobe suppression system

ground aerial system. The thought that secondary radar will commonly be associated with primary radar has encouraged the view that the secondary aerial can most conveniently be mounted on top of the primary aerial—thus achieving a common centre of rotation and avoiding mutual shadowing. To keep weight and windage down, aerials designed for this purpose must be of small vertical aperture. This small aperture means that there must be considerable lobing in the vertical polar pattern, which in itself can be largely compensated by allowing a margin of power in the system, as already discussed, but which is relevant when the sidelobe suppression problem is considered. Reference has already been made to the difficulty of adequate superposition of interrogator and control patterns if different carrier frequencies are used for the two transmissions: a similar problem arises if the frequencies are the same but the aerials are separated.

This problem has been overcome, in the case of the aerial illustrated, by mounting small control radiating elements in the middle of the large interrogator array (the horizontal patterns are shown in Figs. 4 and 5); this means, however, that two separate feeds are required by the aerial (the power levels are in the ratio of about 10:1) which causes difficulty if the aerial is to be mounted on a primary aerial because a triple rotating joint is necessary†. In the U.K. the view is taken that a better arrangement is to mount the secondary radar aerial independently—siting it to its best advantage—and slave it to the primary radar: an added advantage of this arrangement is that the allegiance of the secondary aerial can readily be transferred from one primary radar to another in a complex radar system, and the equipment recently installed at London Airport is designed to work in this way. In the U.S.A., on the other hand, policy is still to mount the interrogator aerial on a primary aerial in appropriate cases, and it is proposed that the control transmission (for a three-pulse system) be provided by a separate (and possibly stationary) aerial. It is the author's view that this must lead to some degradation of performance.

Transponder Suppression

The airborne aerial polar pattern is also of importance in determining reply probability, but little can be done about it except to pick the best available site (and opinions differ considerably on this subject) and cater as far as possible for its vagaries by putting ample power into the system.

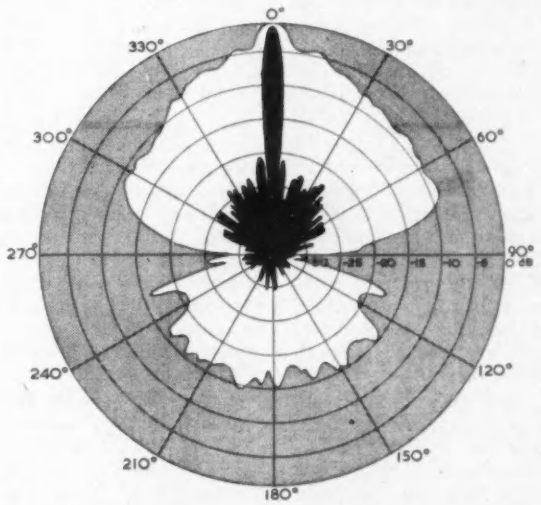

Fig. 5. The radiation patterns of Fig. 4 drawn in polar co-ordinates

Within the transponder, however, there is more scope for the system designer. It is necessary that the transponder, having received one correct interrogation, should be prevented from receiving another until it has finished replying to the first: it is desirable that it should also be prevented from receiving and replying to a reflection of the first interrogation. It is necessary that the transponder should refrain from replying to a sidelobe interrogation: it is desirable that it should be prevented (i.e. positive suppression) from replying to a reflected main lobe interrogation which might follow a sidelobe interrogation. It is desirable that the transponder, having embarked on a consideration of what may turn out to be a main lobe interrogation should not be 'put off' by a reflection of the first pulse of the interrogation or by any other random pulse. It is desirable that the transponder should be prevented from interfering unduly with the operation of other equipment carried in the aircraft. All these requirements call for some temporary densitization of the transponder and hence a reduction in the probability that it will reply to a single interrogation. A compromise between these requirements and that for a high detection probability is therefore necessary, full details of which have not been settled: current specifications call for provision for adjustment in certain respects against the possibility that operational experience may show that adjustment is desirable.

*Second time round responses can be eliminated by the use of swept gain, but the recurrence frequency should be such that the amount of swept gain required for this purpose is not sufficient to distort the vertical coverage of the interrogator-responsor.

†There are two other possibilities. One is to mount the interrogator-responsor on the rotating part of the primary aerial, bringing the signals out at i.f. or video through sliprings; the other is to use a very-high-speed switching arrangement to change from one aerial pattern to another between pulses. Both techniques have the disadvantage of putting complex equipment in that part of a radar which is the most difficult to service.

Coding

Reference has already been made to another requirement for transponder desensitization—that designed to avoid overload on the airborne transmitter. The point at which this becomes necessary depends largely upon the content of the response, and the smaller this can be made the greater will be the probability of receiving a response from the transponder. It also depends upon the average rate at which the interrogator transmits main lobe interrogations; hence increasing the number of interrogations per illumination period by increasing the main lobe interrogation beamwidth or the recurrence frequency tends, in this respect, to affect the reply probability adversely, whereas effecting the increase by decreasing the aerial rotation rate does not.

In its simplest practical form the response would consist of a single pulse—perhaps a fairly long one for easy recognition on the display. In this form the system would be a simple extension of primary radar* providing good cover on aircraft of all sizes and a display free of ground or rain clutter. The temptation to use the system also as an air-ground data-link has proved too strong to be resisted, however, and a fairly substantial amount of coding capability has in fact been specified for the international system.

There are several ways in which the responses can be coded, but it is necessary here to consider only that used in the international system. This consists of two 'framing' pulses, which are present in every response and a fixed distance apart and which are necessary to enable a ground decoder to recognize the presence and location of a response, and a number of intervening 'information' pulses. The positions which the information pulses must occupy, if they are present, are predetermined and the codes are identified by the presence or absence of these pulses. With a set of n information pulses, therefore, 2^n codes can be formed.

Apart from the need to keep the total number of pulses in the response reasonably low there are several mutually conflicting system requirements concerning the nature and arrangement of these pulses. To keep the load on the transmitter down the individual pulses should be as short as possible: to minimize the risk of confusion with noise peaks they should be as long as possible. To minimize the risk of overlap of responses from different transponders (which may give rise to false codes[7]) the train of pulses should be as short as possible: to avoid distortion of the code by reflections the individual pulses should be as far apart as possible. Satisfaction of these requirements must involve some degree of compromise, but the smaller the total number of pulses the more reasonable can be the solution.

Decoding

Once the total number of information pulse positions is increased above four or five it becomes very difficult to read the codes visually on a p.p.i.: a decoder is necessary. There are two kinds of decoder, active and passive, and both may have a place in a traffic control system. A passive decoder is essentially a filter which permits a particular code or group of codes to pass and rejects all others: a bank of such decoders can be used to sort incoming responses in any desired manner. An active decoder is one which, when brought to bear on a particular response, indicates what code is being used.

In common with all other kinds of automatic electronic apparatus, decoders are not infallible, although they may be arranged to fail safe if sufficient information can be sacrificed for parity checking. The insertion of a decoder into the system thus introduces another possibility of reduction of the probability of obtaining and displaying a response from a transponder. Once again, the simpler the coding system the smaller will this reduction be.

The ICAO System

The international system (known in the U.S.A. as the ATCRBS—Air Traffic Control Radar System) agreed at ICAO in 1957 is commendably simple[8]. The system operates in the 1000Mc/s band, chosen as the best available compromise between the need for highly directional ground aerials and omni-directional airborne aerials, and the interrogate and reply frequencies are 1 030Mc/s and 1 090Mc/s respectively. These are the same as for the military i.f.f. Mk.X system: the original U.K. proposal was for a separate system but the U.S.A. authorities were anxious to include secondary radar in their Common System[9] for military and civil aviation equipment. The association of the two systems has the obvious advantage of enabling the civil controller to observe, directly and at the same time, both military and civil aircraft, but all such associations have the disadvantage, from the civil point of view, that conflicts of interest tend to be resolved in favour of the military.

A problem of this nature arose in 1959—by which time ground equipment development to ICAO requirements was well advanced and transponders were being manufactured. The ICAO sidelobe suppression system (s.l.s.) was a two-pulse system of the kind described above: it had been adopted to make it compatible with the i.f.f. interrogation system: s.l.s. not at that time being an i.f.f. requirement (swept gain was regarded as adequate). In 1959, however, the U.S. authorities proposed a change to a three-pulse system. Technically, there is little to choose between the two systems[10], but the three-pulse system appears to be easier and cheaper to graft on to the i.f.f. system wherein there is now a s.l.s. requirement. The matter appears to have been settled by a recent U.K./U.S.A. compromise agreement which, if it is ratified by ICAO, will leave civil aviation authorities free to choose whichever system they prefer and will place on the aircraft operators the onus of carrying transponders which are compatible with the interrogators whose transmissions they will receive. As a solution this arrangement is open to criticism, but what is more serious is the delay of between one and two years in the international implementation of this valuable system (another name for the transponder is the Airborne Safety Beacon) which the uncertainty as to the probable outcome of the discussions has introduced.

The ICAO system calls for two interrogation modes, one of which (Mode A: 8μsec spacing) is the same as one of the i.f.f. modes (Mode 3). The other (Mode B: 17μsec spacing) is required to be a s.l.s. mode and provision for s.l.s. on Mode A is recommended. The possible introduction of two further modes is envisaged and these have provisionally been agreed (U.K./U.S.A.) at 21μsec for Mode C and 25μsec for Mode D.

The basic ICAO code consists of two framing pulses, 20·3μsec apart with up to six information pulses, 2·9μsec apart, within the frame. An additional identification (IP) or 'caboose' pulse can be associated with any code and is selected by a pilot-operated push-button control. This pulse occurs 4·35μsec after the second framing pulse and continues to be associated with every transponder response for several seconds after the button is pressed. The possibility of subsequent extension of the number of codes from the present 64 plus IP to as many as 8 192 plus IP

* *Another name for the transponder, sometimes used in the U.S.A., is a "radar assist beacon."*

(effectively 16 384 including IP) by halving the information pulse spacing is contemplated.

A typical ICAO transponder is shown in Fig. 6 and its associated control unit in Fig. 7. These units are to ARINC dimensional standards (the transponder size is a long ½-ATR) which are internationally accepted for this equipment. A complete installation, with one transponder, including cabling and connectors weighs about 35 lb. It is expected that some airlines will wish to install two transponders in their aircraft as an added safety measure: the weight of such an installation will be in the region of 60 lb.

Possible System Expansion

In addition to the possible extension of the number of modes and codes noted above one other possible additional facility must be mentioned—this is the technique known as Automatic Selective Reply (a.s.r.). In the basic ICAO system all modes and codes are manually selected by the pilot: the idea of a.s.r. is to include a facility for obtaining some information from the aircraft without the intervention of the pilot. The most obvious application of the technique is for altitude telemetry, but other suggestions have been made, such as the determination of the aircraft or flight number[3]. The latter suggestion might be attractive were it not for the penalty in terms of detection probability which its adoption would almost certainly involve, but altitude telemetry deserves much more careful consideration and is discussed further below.

Current Trends

Before pursuing this subject, however, it may be useful to describe what appears to be the general trend of system thinking on secondary radar. There are in fact two distinct trends. In the U.S.A. the tendency appears to be to concentrate on the long-term automatic a.t.c. concept: this leads to such thoughts as the use of a.s.r. and many codes

Fig. 6. A typical airborne transponder for the ICAO a.t.c. secondary radar systems

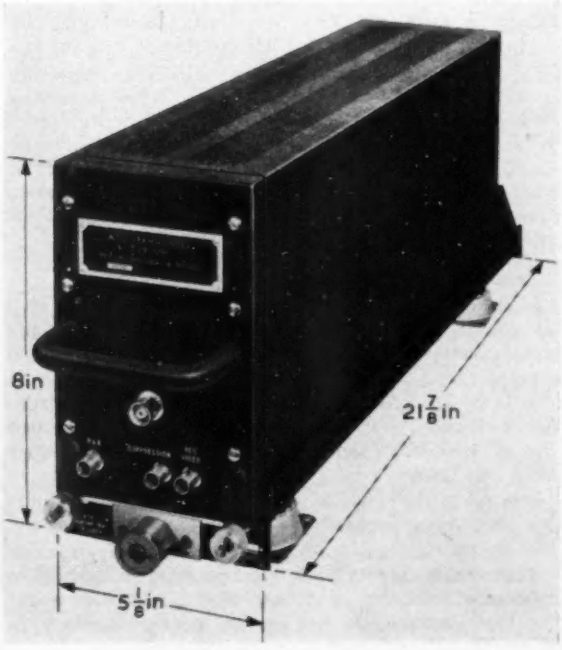

Fig. 7. A typical pilot's control unit for the ICAO a.t.c. secondary radar system

and the implementation of secondary radar in quite a complex form in all aircraft including the smallest. In the U.K., on the other hand, the view appears to be that it is more important to get an elementary system into operation as soon as possible without waiting for a.s.r. and higher coding capability—both of which must necessarily take some years to implement on any appreciable scale.

A different view also is taken, in the U.K., of the small aircraft problem. Here it is felt that such aircraft should carry transponders but of only the most elementary kind possible. This view, however, is attributable at least as much to the difference of the status of 'general aviation' aircraft in this country from that which they enjoy in the U.S.A. as to differences in secondary radar philosophy.

Altitude Telemetry

That there are differences in philosophy, however, is well exemplified by the two approaches to the altitude telemetry possibility. In the U.S.A. the view is taken that a transmission on a particular mode (probably Mode C) should cause the transponder to reply automatically with a coded reading, correct to 100ft, taken automatically from the aircraft altimeter. To do this satisfactorily anything from 400 to 1 000 codes will be required—thus increasing the number of information pulses in the response from six to nine or ten (and quite possibly to twelve or thirteen in case some additional facilities are required)—and there will almost certainly be a need for two extra airborne boxes, one to digitize the altimeter output and one to provide the a.s.r. and coding.

In the U.K .on the other hand a much cruder system is about to be tried experimentally with the London Airport installation[11,12]. This uses only the codes currently available in the basic ICAO system, giving heights correct to 500 or 1 000ft according to altitude, an automatic digitizer which already exists[13], manual selection of the facility (not the codes) and a slightly modified ICAO transponder*. This does not mean that the U.K. authorities are opposed in principle to the introduction of a.s.r. and all that goes therewith, but it is quite clear that this simple system could be implemented much sooner than that being discussed in the U.S.A.

The Future

It is clear that the secondary radar system can develop in either of two ways. One is that typified by the U.S.

*The transponders used are of the pattern illustrated in Fig. 6, modified by the addition of little more than a plug and box of relays. The control unit is that illustrated in Fig. 7, with the unused Mode D position rechristened "Mode Z" and wired to select the telemetry facility.

approach to altitude telemetry: an increase of emphasis on the data-link aspect of its functions and on its relationship to automatic air traffic control as a long-term development. The other is a rapid implementation of the system as an adjunct to primary radar and human a.t.c. systems, with system elaboration only where operational experience shows it to be necessary: for example, apart from the use of codes for altitude telemetry, nobody has yet proposed a use, for procedural purposes, for more than a tiny fraction of the codes available in the basic ICAO system: it seems early, therefore, to be discussing a substantial extension of the system coding capacity for any purpose.

If it is thought that too much of the foregoing has been concerned with the problems and disadvantages of the system and too little with its undoubted advantages the defence must be that at this juncture it seems advisable to try to temper the zeal of the faithful by drawing attention to some of the pitfalls which lie in the way. It is the author's view that the system cannot develop, internationally, in both the directions mentioned above: it is also his belief that a thorough consideration of the limitations of the system must lead to the conclusion that the data-link development is best left to systems like AGACS[14] and that the proper direction for secondary radar development is the other one.

Conclusion

Secondary surveillance radar exists: the carriage of transponders is already mandatory for many aircraft operating over the U.S.A.: it is expected that there will shortly be similar requirements elsewhere[15]. Properly employed it can reduce cockpit workload, relieve pressure on r.t. communications, make life a little easier for the air traffic controller and contribute to the greater safety of air travel. It can do this if it is employed in its principal role—as a reliable long-range surveillance radar which can also obtain some useful extra information.

Acknowledgments

The author wishes to thank the Directors of Cossor Radar and Electronics Ltd for permission to publish this article.

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The Malvern Interferometer Telescope

THE Royal Radar Establishment of the Ministry of Aviation has installed a Radio Telescope Interferometer at Defford, near Malvern, for the radio exploration of the upper atmosphere and space. The equipment consists essentially of two steerable and mobile radio telescopes with parabolic reflectors 25m (82ft) in diameter, which can be used either separately or in conjunction as an interferometer. The radio telescopes can be operated over a wide range of wavelengths down to a few centimetres. The spacing between the two aerials can be varied up to about 1 000m and when the aerials are connected together as an interferometer they can make measurements of direction as accurately as a single aerial of diameter equal to twice the spacing.

The equipment will be valuable not only for research into space phenomena observable by radio and radar methods, but it will provide a suitable instrument for the trial of new techniques of observation.

The new installation is different from but complementary to those at Jodrell Bank and Cambridge[1], and at Malvern[2] and it will particularly help to fill the gap in observations at shorter wavelengths.

It is intended to use the equipment for observations of radio emissions originating from many different sources such as radio stars, the sun, moon and planets, earth-satellites and space probes. The main contract for the construction and assembly of the telescopes was awarded to the Dutch firm of Werkspoor who have constructed a single telescope at Dwingelo in Holland on which the design of the present telescopes was based.

Choice of Site

Several factors determined the choice of a site: it had to be nearly flat over distances of about 1km and with no screening of the field of view above a few degrees of elevation, with freedom from sources of radio interference, and within reasonable distance of the main Establishment at Malvern. The former Defford airfield fitted these requirements satisfactorily, as well as providing runways suitable for the laying of tracks to support the mobile radio telescopes.

Movement of the Radio Telescopes

Each radio telescope is mounted on a carriage which in plan is of the form of an equilateral triangle and which is supported by an eight wheel bogie at each corner.

Two of these bogies run on a single standard gauge rail track and are driven by electric motors of total capacity of 80 h.p. to provide the motion of the telescopes along the track.

The third bogie, which is not driven, runs on a similar rail track running parallel to the other track and spaced 90ft from it.

The total weight of each telescope with its carriage is about 250 tons.

Each radio-telescope has its own double track of this

type, and the two are laid in the form of a letter 'T', the lengths of the tracks from the intersection being 750m. When the telescopes have been brought to the required position they are levelled by means of hydraulic jacks. On each aerial, running, braking, levelling and locking are all controlled from one panel.

Electrical power for driving the telescope along the track and for the operation proper of the telescope, totalling in all some 100kW, is supplied by trailing cables.

The Interferometer Principle

When two separated aerials are connected as an interferometer the aerial pattern consists of a fan of narrow beams; the width of each beam becomes narrower as the spacing between the two aerials is increased. The angular discrimination is thus greatly improved and is determined by the spacing. Thus very accurate measurements of angular positions are possible on isolated sources. An interferometer with mobile aerials can be used for the determination of the size and shape of sources of radio emissions. This is achieved by the method of aperture synthesis in which observations obtained with the aerials at various spacings in different directions are combined. The resolution corresponds to that which would be achieved by exploring the sources with the very narrow beam produced by an aperture of dimensions comparable with the largest spacing.

The aerial photograph shows the two radio telescopes on their separate tracks. The central control house can be seen in the foreground

Angular Accuracy

The pointing errors of the radio telescopes have to be small compared with the beamwidth. A 25m reflector gives a beamwidth of about 20 minutes of arc at $\lambda = 10$cm, so that pointing errors should not exceed 2 to 3 minutes of arc. The accuracy of the interferometer depends on the length and stability of the baseline, and with a spacing up to about 1 000m an angular accuracy of a few seconds of arc can be achieved.

Construction of the Radio Telescope Reflectors

Although the radio telescope reflector is closely parabolic in form, it is in fact made up of 1 464 triangular flat sections. These are in sets of 4, each set being separately adjusted to the correct position after mounting in the reflector framework. In this way high accuracy can be attained. The reflector is constructed of wire mesh to minimize heating effects and consequent distortion. The central region about 20m in diameter, is of fine mesh composed of wires 1·25mm in diameter with 7·25mm spacing. The remaining outer part, to 25m diameter, is of slightly thicker wires with about twice the spacing. This concession in the outer mesh eases mechanical construction without serious detriment to the performance since it entails only a small loss of efficiency. The focal length of the reflector is approximately 12m and the position of the aerial feed at the focus can be adjusted by a mechanism behind the reflector.

Control System for Pointing the Radio Telescopes

The reflector mounts are provided with servo-motor drives by which they can be rotated in azimuth and elevation. The central pivot for azimuth rotation takes about half the load, the other half being shared by four wheels running on a horizontal circular rail of 16m diameter mounted on the mobile carriage. The system is designed to give a pointing accuracy of better than 3 minutes of arc at azimuth and elevation rates up to 18 and 12°/min respectively in normal working conditions and wind speeds up to 20 mile/h.

Connecting Cables

The cables combining the radio signals from the two radio telescopes must satisfy certain stringent conditions; for instance, there must be little change of electrical length due to temperature fluctuations or moisture, and reflections at connecting points and attenuation in the cables must be small. Coaxial cables are used of which the outer conductor is a solid aluminium tube filled with dry pressurized air, and the inner conductor is held by a helical membrane spacer. For thermal insulation and protection, the cables are surrounded by glass wool and bituminous felt and placed in concrete cable ducts. Connecting boxes with specially designed connectors are placed at intervals of about 50m along the cable run. Some 8 500 yards of low-loss helical membrane cable and 6 000 yards of 25 core data cable supplied by Telcon were used to connect the two telescopes to the central control room.

Radio Transmitters

The cabins mounted on the radio telescopes are large enough to hold two high-power radar transmitters as well as receiving and other apparatus. At present a transmitter with 2½MW peak power and 5μsec pulse length working at a frequency near 1300Mc/s has been installed in one of the cabins and in the other a transmitter with 100kW peak power, 200μsec pulse length, with operating frequencies at 300Mc/s and 500Mc/s. When necessary one radio telescope may be used for transmission and the other for reception to eliminate some of the difficulties which can arise in common transmitter-receiver systems with highly-sensitive receiving devices.

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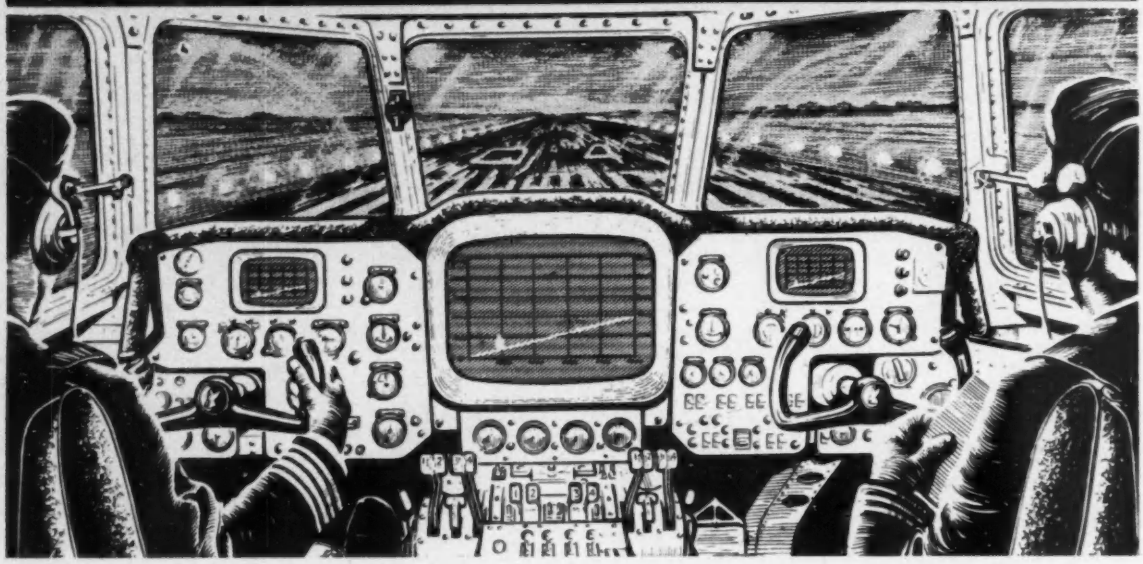
Aircraft Landing Techniques



...and the Future

By R. E. Young*, B.Sc., M.I.E.E., A.F.R.Ae.S.

The trend towards fully automatic control of landing as part of the complete flight sequence is examined from the point of view of the 'user'.

Difficulties, such as that of securing international agreement, which would arise in attempting to obtain universal adoption of a given automatic system are outlined and alternative techniques suggested.

These techniques are: for landing, combined infra-red/Teleradar, and 'Derived Information' ground based systems, and, for air traffic control, a particular form of 'height colour' radar information presentation.

Throughout emphasis is placed upon the need for information to be presented to operators with the utmost rapidity and without ambiguity arising in any way.

(Voir page 546 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 553)

FOR air transport to take its place fully with other means of carrying passengers and freight, it must be completely independent of weather conditions; and this requirement appears in its most outstanding form in the need for aircraft to be capable of taking off and landing in 'zero visibility'. It is one of the main purposes of this article to examine this far-reaching operational requirement—from the point of view of development of landing systems for aircraft. However, ground equipment and techniques (e.g. radar surveillance) must be considered in some detail at the same time because of the complete interlinking that must be established between the aircraft and air traffic control.

The general tendency is, in fact, for precedence to be given to the traffic handling side and for the design of the aircraft equipment to be subordinated to the needs of the ground control arrangements. The explanation for this is to be found in the load placed on the latter by rapidly increasing air space congestion and the consequent large amount of information which has to be handled and utilized in such a way that correct instructions are always given to all aircraft.

Such are the demands of the overall air traffic control 'complex' that the ultimate answer is almost certain to be weighted heavily towards a system in which entirely automatic take off and landing are part of an overall control process, in which the aircraft completes the whole flight sequence without direct human intervention.

To arrive at such a final condition will obviously involve a number of stages of development; and, as is discussed later, it is likely that only large airports and their Service equivalents will have complete installations of automatic flight control equipment. Thus a need will almost certainly continue to exist for much less complex landing systems suitable for small airports and even semi-permanent airstrips. With such a parallel existence of two systems it is preferable for them to be not only com-

* *Formerly Sir W. G. Armstrong Whitworth Aircraft Ltd.*

patible but to be integrated to give reserve and other facilities within the overall aircraft control concept.

Suggestions are made to meet these requirements in terms of proposals made in the past and discussed with 'users' and other interested parties. The techniques as suggested are considered to point the way to systems with definite attractions, especially if they were allied with the latest developments in the radar and associated fields.

The Present Position

One of the main objections to the general adoption of complex landing methods is that it is extremely difficult to evolve a system which is acceptable to all types of user. Thus the universal system must cater for the jet airliner and the small executive aircraft, while a comparable situation exists at the air traffic control point where the ground installation must be just as applicable to the small airfield as to the large airport.

These and similar considerations, including the closely linked economic ones, almost certainly explain why ground control approach (g.c.a.) has remained without an alternative as the only final phase landing aid in regular use since its introduction in the mid 1940's. G.C.A., as will be noted again later, is particularly attractive in this context because it obviously places no extra demands for equipment on the aircraft operator; while, as a counterpart, even the necessary ground radar can be regarded as something which has an application wider than its use for landing aircraft under adverse conditions.

The Immediate Future

The greatest civil demand for automatic landing arises from the need to maintain scheduled services on airlines, and it is in this sphere that the problems arising with the landing of conventional aircraft are becoming increasingly acute. This can be associated with two main causes, one being the pilot himself, and the other the air traffic control system, i.e. both aircraft and ground control are involved, and are becoming more and more interdependent. Also the air traffic control problem is becoming greater as time goes on because of the increase in traffic density which tends to produce a worsening situation as a form of vicious spiral.

In the case of the pilot, aircraft speeds and the reaction times necessitated by them are becoming such that, even now, he (as a human operator) is becoming a limiting factor and a serious one at that. Consequently, when landing conditions are other than near-perfect, the chance of error and hence the liability to at least a minor accident, becomes more significant.

The integration of the pilot's section of the overall landing operation with the air traffic control system as it now exists, presents an even greater problem if landing is made an automatic process, unless the whole air traffic control system is transformed into an automatic one as well. However, the resultant overall complexity would be of such an order that from the point of view of cost alone it would tend to be ruled out for a long time to come. Furthermore, for these applications reliability must be beyond doubt; and with the precautions necessary to ensure this equipment and system reliability, the cost is increased by a considerable factor to meet the probabilities involved.

An even greater obstacle to the adoption of this type of system is, and will continue to be, the need to develop and equip airfields with standard gear which will satisfy all users on an international basis. To obtain international agreement is difficult when only a few countries are concerned; but as indicated earlier, in this case a solution offered must have world-wide acceptance to become effective. Also these difficulties are almost certain to be accentuated by individual countries having already undertaken development at considerable cost, and to have reached an advanced stage of technological achievement with a specific system which they will not want to abandon.

It has already been pointed out that a landing system must be suitable for both large and small aircraft, for both the jet airliner and the small executive aeroplane. By the very nature of the latter type of aircraft and its duties, it is unlikely that it will ever cease to be 'piloted', at least in the foreseeable future; while cost in this case would probably rule out landing aids requiring additional complex airborne equipment.

Bearing in mind the foregoing considerations, it is possible to establish the main essentials of the ideal blind landing scheme.

First of all when it is introduced it must not demand major alterations either in the air or on the ground. This, in turn, means that both the airborne and ground equipment must be made as self-contained as possible (in the sense that there should be no major inter-dependence with other systems) and also possess the minimum of complexity.

As far as possible major changes in procedure should not be demanded from either the pilot or the airfield controllers. Methods which have been built up as the result of experience over the years should not have to be 'unlearned', as there is always the tendency, especially under stress, to revert to the original procedures.

It is sometimes suggested that the simpler form of landing aid, particularly those having some form of visual presentation, should be retained for monitoring while under automatic control. The main object of such monitoring is considered to be, in this case, to enable the pilot to detect trouble and to take over control in this event. It is felt that unless some form of 'anticipation' can be introduced into the present conventional systems, especially with the increase in landing speeds that is taking place, the time taken for appreciation of the development of a fault, added to that required to take over control, would be far too long, i.e. final corrective action would almost certainly be taken too late. Also, in general, monitoring information is derived from the control equipment itself which therefore renders it suspect, if not useless, in an emergency.

In contrast it is quite widely held that for many years to come pilots will demand some sort of visual presentation of the various stages of final approach and touch down. This attitude has been described as representing in part a requirement for a 'tranquilizer', and it may well be that this particular attribute might be put to good use. Thus if full confidence were developed by the pilot in such a monitoring facility, he might be sufficiently detached to be able to detect dangerous trends and take appropriate action in good time, despite the rapidity of occurrence of the various events.

Teleradar System

The Teleradar system to be described is given as the most direct method of attack on the problem of providing a basic landing system which could also be used for independent monitoring in conjunction with full automatic control

As originally proposed[1], a pulse radar aerial head in the nose of the aircraft scanned suitable radar reflectors spaced along the runway boundaries and transverse

identification lines. This scan pattern, synchronized with a raster built up on a cathode-ray tube screen to give a perspective display to the pilot, would be of the 'television' type, i.e. it would have vertical and horizontal sweeps of considerably different rates. In this case appreciably greater scanning amplitude is required in azimuth than in elevation (larger divergencies in approach are possible in the horizontal than in the vertical plane) so that it would ease design to make the vertical sweep the faster.

The achievement of a practical Teleradar system, meeting desirable resolution and similar requirements, depends on solving two major problems:

(1) To produce the required narrow radio beam.

(2) To develop a suitable aerial system capable of scanning at a sufficiently high rate.

Assuming that a relatively conventional dish reflector is used with mechanical scanning, the employment of the shortest possible wavelength is indicated consistent with adequate range performance. This must be determined in terms of the well-known absorption phenomena due to rain etc.; although for a given size of dish the desirable narrowing of the beam with decrease in wavelength is accompanied by an improvement in signal-to-noise ratio owing to the increase in aerial gain.

To obtain a high scanning rate is an extremely difficult matter, while it is demanded by two major considerations—what may be termed the 'flicker problem', and, secondly, the insufficient number of 'returns' per scan cycle obtained at long range.

With regard to the first it might be possible to use a display tube phosphor with a pre-determined after-glow decay rate to produce a satisfactory display from relatively slow scan rates. The decay would be selected to die away at a rate linked with the apparent movement of the marker reflector images over the screen, and, by this 'smear' effect could improve the picture and would also directly reduce flicker. In addition, some slight improvement in signal strength would result from the integrating action of the afterglow.

It is not possible to produce equivalent straightforward suggestions for dealing with the number of returns per scan because this is a typical engineering design case in which many inter-related and, in general, conflicting, factors have to be reconciled.

However, the order of certain parameters can be established, e.g. the dish diameter would be approximately 3ft, as a maximum for such an installation in the nose of an aircraft. As a consequence an operating wavelength of less than 1cm would have to be adopted to obtain a radio beam width of under 1°—required for the resolution criterion.

Although increase of pulse recurrence frequency makes a useful contribution to the improvement of returns per scan, reduction of dish excursion angle to allow higher scan speed holds the greatest promise for alleviating this situation. A suggestion follows which meets this point and is also considered to bring other advantages in its train.

The proposed scheme, illustrated in Fig. 1 is a combination of infra-red and radar working. Proposals have been made in the past in which infra-red sources have been used as runway markers, but the general indications are that the range performance of such a system would be inferior to the radar equivalent described in this section. However with a combined system the radar parameters, such as scan angles, could be relaxed as indicated for long range presentation, while infra-red would be satisfactory for the short range phase.

The physical arrangement would be as follows:

Ground markers would consist of combined corner reflectors and infra-red radiating sources as in Fig. 1.

In the aircraft, the display would be common to both signal systems and would be fed both by the radar head and an infra-red image convertor. The two scanning frequency groups would be linked to give a satisfactory transition from one type of video signal to the other by making the infra-red frequencies multiples of the radar ones.

It must be stressed that this outline scheme is based upon types of equipment which have been in existence for some time, and that future developments might enable the pure radar system to be adopted in its entirety. Examples are the possibility of substituting an electronic means for mechanical scanning and a dielectric lens assembly for the conventional reflector dish.

One of the main attractions of such a system is that it is virtually independent of ground installations—particularly telling in remote areas where appropriate staff are not available for maintenance of complex equipment. Even the addition of infra-red sources to the corner reflectors would almost certainly necessitate no more skilled maintenance than is required for normal runway lighting.

A possible development is to produce a composite radar set with two roles, cloud/collision warning and Teleradar landing. The economic advantages of combining the two groups of equipment, which would have much in common, would be considerable; while an alternative would be to retain two individual sets which would provide 'backing-up' and reserve facilities for each other.

Derived Information Landing System

In contrast to the Teleradar scheme the major installation is situated on the ground and only simple airborne equipment is employed. Furthermore, all the gear is conventional and would be either available or could be made available comparatively easily.

The major part of the information is presented in pictorial form to the pilot via a ground-to-air television link. He would see on the screen of the receiver cathode-ray tube in his aircraft the position and movement of the aircraft relative to the ideal glide path, range from touch-down and height, all forming a continuous picture without time lag.

The remainder of the information is passed to the pilot by what is, in effect, a 'speech channel' to the pilot's headphones on his (airfield ground control) v.h.f. link frequency used during landing. This is required to place the aircraft over the runway, i.e., to give plan or azimuth indication, and would be provided by a dot-dash pattern spaced symmetrically with respect to the runway (Figs. 2 and 3 show two methods for providing this pattern). The runway would be at the centre line of the steady signal zone produced by the geometrical overlap of the complementary dot and dash signals. Means would be provided to superimpose or, in some cases of emergency, to substitute conventional g.c.a. instructions on this communication channel.

The derivation of the vertical plane information to be sent from the ground would be from a pulse height-finding radar with a display on which the aircraft would appear as a conventional 'blip' with the ideal glide path shown as a 'bright up' line on the ground radar display.

A range and height grid, suitably scaled, would be superimposed on the height finding radar display and the

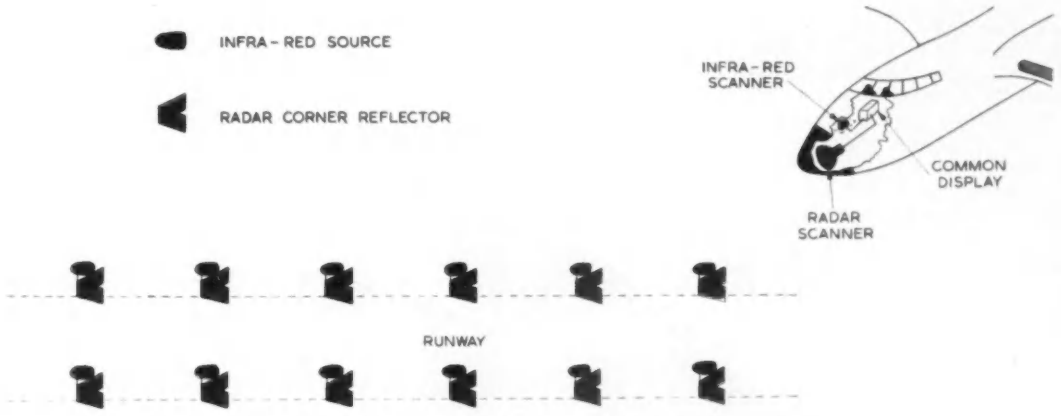


Fig. 1. The 'Teleradar' system using a combination of infra-red and radar

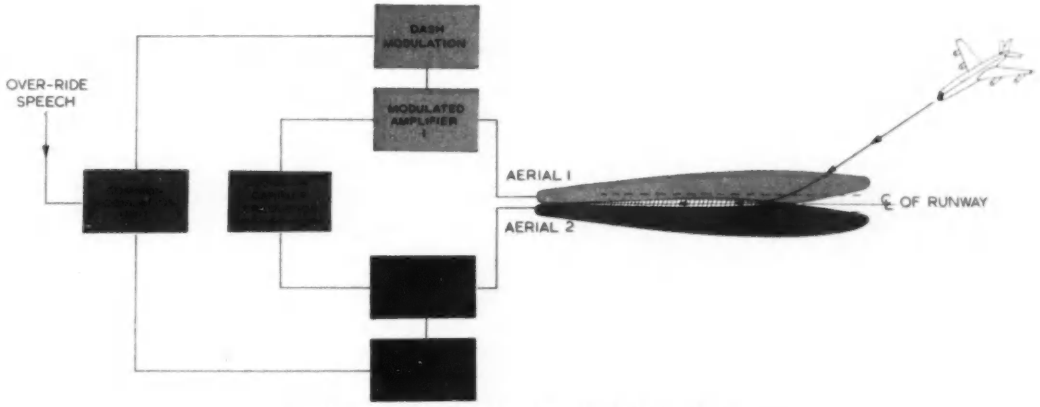


Fig. 2. A ground based landing aid—maintained azimuth pattern

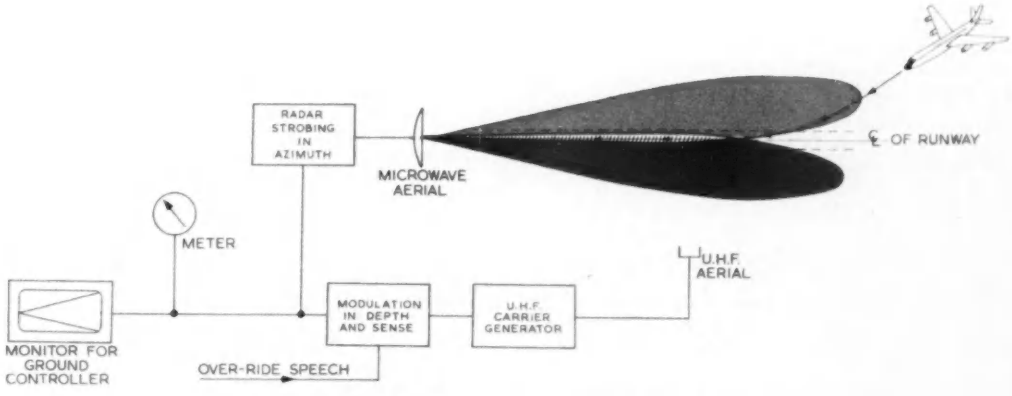


Fig. 3. A ground based landing aid—derived azimuth pattern

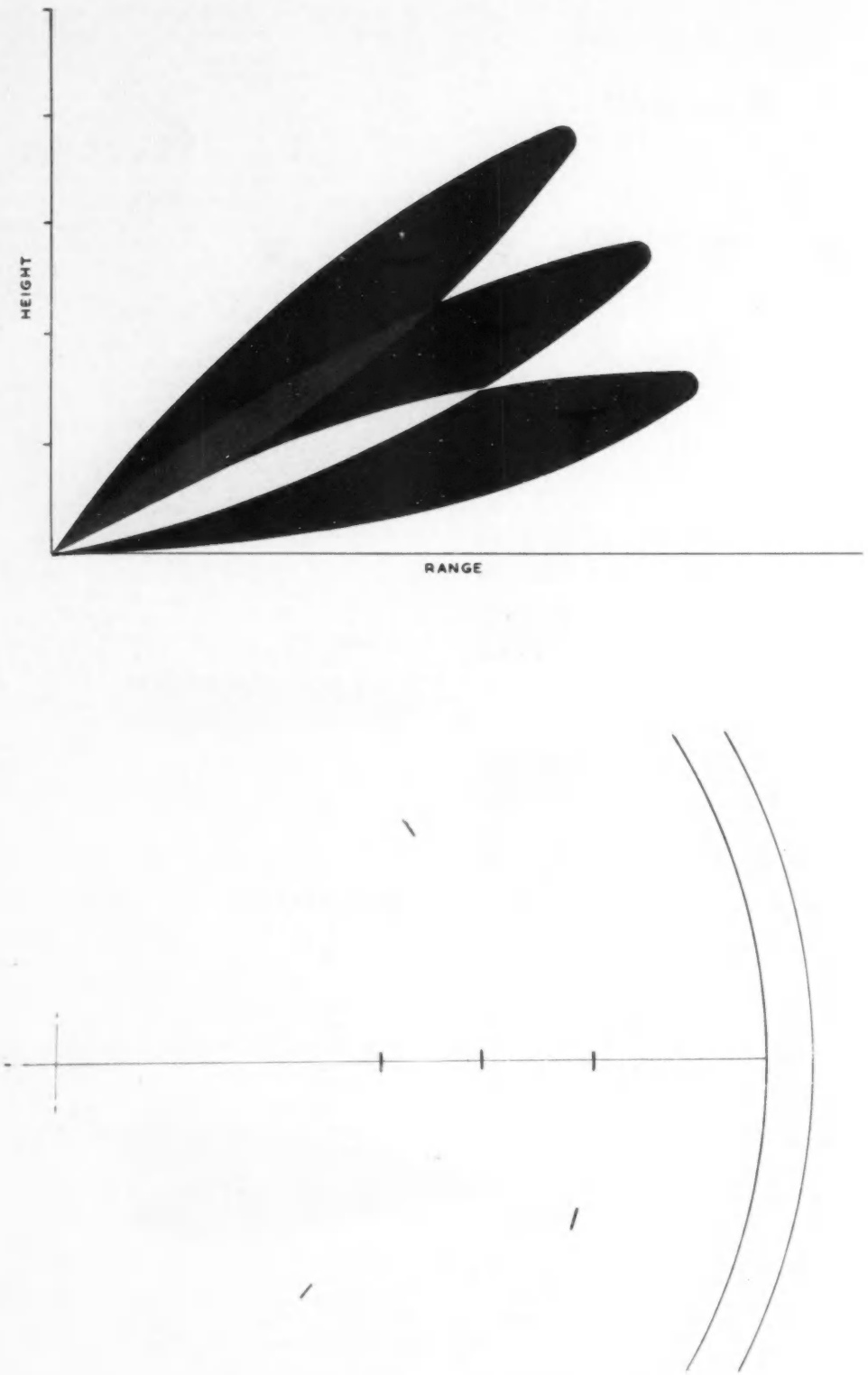


Fig. 4. Height colour radar-lobe presentation
The three 'paints' shown on the horizontal line in the lower section of the diagram correspond to the three aircraft shown in the top section

composite picture transmitted by normal television methods to the aircraft.

By employing a c.r.t. screen with appreciable afterglow, the flight path of the aircraft relative to the glide path can be seen literally as a picture with 'distance to go' and rate of descent also presented without any intervening time lag.

With a g.c.a. landing, the time lag due to the verbal passing of information is added to the operator time delays which occur both in the ground control station and in the aircraft due to 'translations' between various forms of communication.

Furthermore, with a g.c.a. system the controller has to combine two displays mentally and then issue the appropriate orders, which leads to considerable fatigue, with consequent danger of error in addition to that due to delay.

With the proposed system, the visual sense of the pilot is, as it were, coupled directly to the controls in the vital process of 'bringing the aircraft down' (viz. landing in the vertical plane); while the placing of the machine relative to the runway is done by virtue of the audible sense of the pilot, a process which is known to be capable of being made 'semi-automatic' (without conscious thought as such) by training.

The resultant display is shown on the large central monitor of the heading illustration on page 496. It will be noticed that this main display screen is placed to the side of the pilot (the smaller displays are meant to be 'general purpose,' and, although capable of being switched to the Derived Information system output in an emergency, would be normally connected to other systems e.g. cloud/collision).

The reason for this is that the initial reaction of some pilots is that they 'do not wish to see themselves sideways on.' In other words they feel that they could not get accustomed easily to a presentation other than the direct aircraft view type given by Teleradar.

On the other hand experience indicates that aircrew soon get used to a g.c.a. form of a display, which is what is involved here; and, by putting the display well out of the pilot's direct landing observation region, he might find that he was using it naturally despite its being an entirely new method of judging approach to the runway.

On the ground installation side the display of the height-finding radar, whose microwave aerial scans over a suitable angle in the vertical plane, appears on two monitors. One of these monitors feeds the television transmitter and its aerial through a conventional relaying chain. A range and height grid on the monitor screen would be shown by this means together with additional notes as necessary, including specific instructions in cases such as breakdown of a communication channel. A parallel monitor would be provided for the ground controller to observe the landing when required and override the 'speech' transmission.

The interlaced dot-dash pattern required in azimuth is laid down by the two parallel transmitting systems with common modulation and carrier frequency generator units, as in Fig. 2. Such a transmitting system would be directly applicable to automatic landing in the horizontal plane.

As it stands, this arrangement would not give the same indication to the ground of the position of the aircraft in azimuth as is provided by the height finding radar in the vertical plane.

The alternative method of Fig. 3 employs a radar strobing in azimuth which provides the dot-dash transmission to the aircraft. In this case, however, the sense and depth of the modulation sent to the aircraft over the one v.h.f. link is varied according to the position of the strobe relative to its centre position (echo over centre of runway). Apart from the position as shown on the p.p.i. type display this modulation is monitored also on a meter as shown, to give visual indication and also to feed a recorder if desired.

The added advantage of such a strobing system is that the strobing meter could be reproduced as part of the television picture in the aircraft to give a visual indication to the pilot of his position in azimuth. This would not introduce confusion as it would be entirely dissimilar from the radar picture, and would be an adjunct to the audible indication and a replacement for it in the event of the breakdown of the speech channel. In both methods it would be advantageous for the ground controller to hear the dot-dash signals as an aural check on the position of the aircraft relative to the runway, to enable him to concentrate for monitoring purposes on the vertical plane display, and, to reduce the possibility of confusion by trying to cover the two radar displays simultaneously.

In all cases the radar installation required is no more complex than for a conventional g.c.a. station; while no modification, such as the fitting of a radome, is required to the aircraft, but only the installation of a small television receiver and a small aerial.

The major advantage of such a system can be claimed to be that the pilot is given information in such a way that his mind is not consciously spread over a number of matters during a most difficult period when events are occurring extremely rapidly. In this case he gets literally a complete picture from his television monitor without having to synthesize it from a number of sources.

Before passing on to the future of air traffic control, it would seem apposite to examine from the ground control point of view these two systems which have just been described. To gain a complete picture it is necessary to bring in the pilot's appreciation of the schemes, because without this a large element in the overall control problem is missed.

As implied earlier, ground control approach must be regarded as an extremely successful system, which, for the immediate future, has no competitors. Its main drawback, as has been indicated, is the time lag interposed by it in the control chain between event and pilot's action; and this is accompanied by the possibility of error. It says much for g.c.a. controllers the world over that the incidence of such errors must be described as negligible, but pressure on controllers is steadily increasing with accelerating growth of traffic and higher landing speeds.

Both of the schemes offered as alternatives to g.c.a. do eliminate these particular disadvantages. In addition these schemes do not follow the general tendency to build up instrumentation aids of various types to an unprecedented degree of complexity. That this complexity is considered to be potentially dangerous is shown vividly by the artist's impression—"The Clock Shop Cockpit" in a paper by Fogel[2]. In this paper various methods of presenting flight information are reviewed, and the general impression which is given is one of excessive complication, demanding too many 'reading' actions by the pilot in too short a time to be effective, even for the lower landing speeds.

Reverting to comparison of the two new schemes within

the air traffic control framework, it is possible to arrive at a relatively clear cut assessment from simple considerations.

Teleradar obviously has advantages for use in isolated areas because of its self-contained nature. Its very self-sufficiency, however, making it independent of the ground controller for the landing process, carries with it the potential danger of the pilot neglecting to maintain continuous contact with Ground Control and thus failing to be appraised of the presence of other approaching aircraft. Thus on busy airfields with automatic landing the Teleradar system should only be used for independent monitoring or for landing under emergency conditions.

The ground-based system on the other hand ensures that the approaching aircraft conforms to the pattern determined by the ground control staff since they, in effect, would command all the information to be conveyed to the pilot.

With the elimination of time lags and potential 'handing-on' errors of the conventional g.c.a. system, increase in confidence of both air-crew and control staff should follow. This should result in an improvement in traffic handling speed by virtue of this increased confidence as well as more directly from the quicker communication of data. With high landing speeds these factors could be vital in terms of safety.

Air Traffic Control—Presentation of Information

Wherever control is to be exercised over air traffic it is essential that the staff concerned should be presented as clearly as possible with the maximum information on all aircraft in their area. An I.E.E. Symposium[3] held last year brought out with full force the major effort which has been put into the development of data presentation systems for this purpose and the realization of the need for them which had prompted the work.

As must be regarded as inevitable, these data presentation systems become extremely complex, one of the main problems being to display the large amount of relevant information associated with a given aircraft 'plot.' It must be accepted that under conditions of high density aircraft movement ground control operators will have considerable difficulty in assimilating all this information and taking correct executive action with sufficient speed.

One of the main deficiencies in the presentation of an overall air traffic control 'picture' by existing methods is the non-availability of a satisfactory three dimensional display; and attempts to cover this deficiency by adding more numerical information to digital labelling would appear to increase the near-stultifying effect on control operators which might be expected in extreme cases.

One method[4] of conveying three dimensional indication, which the author feels has definite advantages because it is closely linked to existing forms of display, is that of 'height colour mapping.'

Although straightforward height indication would correspond with that showing relief on a layer coloured map, i.e. a specific colour would be associated with a height layer established between upper and lower limiting planes; an alternative method would be to link colour with a given aerial main polar diagram, Fig. 4. This might have a definite application for long range traffic monitoring and control.

For example, B.O.A.C. jet airliners start their 'let-down' to London Airport over Wales, and consequently a clear check on their path of descent and on that of any other aircraft in the same map sector could be maintained without ambiguity. The latter point is considered to be of major importance, both in this application and for 'height layer' working, because plan position and vertical position are indicated on the same display and error cannot occur in cross reading the two separate displays of the conventional height finding radars. It is also considered, as is illustrated by Fig. 4, that there is much to be gained from many aspects, particularly that of safety, with this type of presentation because the nearness or otherwise of aircraft in space is immediately apparent to the observer.

As with the Teleradar case, the technical suggestions involved have been made more as pointers to the techniques that could be exploited to meet an operational need than as the only solutions. They have, however, been discussed with those knowledgeable in the art; and with these discussions in mind, it is submitted that some points raised by inference, may well assume more importance than the statements themselves.

Acknowledgments

Acknowledgements are due to the Directors of Sir W. G. Armstrong Whitworth Aircraft Limited for permission to publish this article. The material has been prepared under their aegis but the views expressed are those of the author and are not necessarily those of the Company.

Thanks are also due to Mr. E. D. Keen, Chief Designer and Director, for his help and encouragement.

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Voice Frequencies Over Telegraph Lines

Compact fully transistorized frequency modulated telegraph equipment to convert teleprinter or data intelligence into voice frequency signals and transmit the signal over telegraph circuits has been developed by Associated Electrical Industries Ltd. Designated type CT24A, the equipment can send and receive information via a maximum of 24 telegraph channels over any four-wire bearer circuit capable of transmitting the frequency range 300c/s to 3 300c/s and having a performance conforming to CCITT recommendations for an international speech circuit.

Teleprinter or data information is usually encoded into positive or negative pulses of direct current which are not suitable for transmission over lines or radio links where audio frequency amplification equipment may intervene. It is therefore necessary to interpose equipment which can, for transmission, translate the d.c. pulses into corresponding pulses of alternating current at voice frequency, and, for reception, translate voice frequency pulses back into d.c. The polarity of the d.c. pulse can be imposed on the voice frequency signal either by amplitude modulation or frequency modulation.

An f.m. system, compared with an a.m. system of the same capacity, is inherently less affected by variations in the amplitude of the signal being transmitted, has improved signal to noise ratio, wide signal level range, responds better to rapid changes in the level of the signal, and gives performance at higher operating speeds for a given frequency spacing between channels.

However, the use of f.m.v.f.t. has until recently been confined to a relatively small number of circuits in a few national networks, as the improved performance was obtained with greater terminal cost and complexity.

These disadvantages are largely overcome in the Type CT24A equipment, where the use of modern components and construction techniques has produced economical, reliable and compact terminal apparatus which is easily serviced. The complete equipment with power supplies can be mounted in a standard 19in rack 9ft high.

Operating speed is normally 50 bauds but operation up to 80 bauds is possible if a slight increase in the telegraph distortion can be tolerated.

Cathode Coupled Cascode Stabilizer Circuit

By S. G. Jones* and R. S. McClean*

An amplifier circuit with high gain and relatively low phase-shift allows the design of a high performance negative high-voltage supply in which stability is easily achieved.

(Voir page 547 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 554)

SINCE the publication in 1955 by Attree[1] of 'A Cascode Amplifier Degenerative Stabilizer', this circuit and modifications of it have given excellent service in experimental equipment developed in these laboratories. Fig. 1(a) shows the usual cascode amplifier circuit, and Fig. 1(b) shows the modified circuit of Attree. The cascode circuit can provide large voltage gain similar to that usually associated with a pentode stage. The gain is approximately equal to the product of the mutual conductance of the lower triode and the load resistance R_L. Unfortunately, the mutual conductance of a triode varies widely with anode current, falling to low values for small currents. For the usual cascode circuit, satisfactorily high gain is obtained only for high currents through R_L. If the amplifier is supplied from the stabilized output at the cathode of the series valve, this high gain region of amplifier operation implies a relatively small range of relatively large negative grid voltages on the series valve. This is unsatisfactory as regards both series valve efficiency and the restricted range of input and output voltage and output current variations which can be handled. The modified circuit has the advantage of maintaining high gain for low values of current in the load resistance. With a standing current in the lower triode, by way of the resistance R, the mutual conductance of this valve, and hence the stage gain, remains approximately constant over a wide range of currents in R_L. This allows the load resistor to be supplied from the stabilized output voltage, virtually eliminating undesirable feedback effects encountered when the amplifier is supplied from the unstabilized voltage. The full stage gain is available to provide good stabilization and low output impedence over a wide range of input voltage and output load conditions.

Stabilizer Circuit

A power supply was required to provide negative output voltage from 2·4 to 5·2kV at load currents up to 0·5A. Output voltage fluctuations of ±1V due to load variation, ripple and input voltage variations could be tolerated. A block diagram of the configuration chosen for the supply is shown in Fig. 2. Because water cooling was available in the equipment with which the supply was to operate, a type 3W5000A3 triode was chosen as the series valve. Otherwise, the air-cooled equivalent, type 3X2500A3, could have been used. A direct-coupled amplifier with gain A in excess of a thousand was required. It was desired to retain the simplicity and convenience of the modified cascode circuit. Because the gain of the amplifier is maintained for small currents in the load resistance, only one auxiliary supply, with its positive terminal grounded, was required. However, some method of obtaining an additional error signal inversion, without loss of gain, had to be devised if the chosen stabilizer configuration was used.

If the lower triode of the modified cascode circuit was replaced by a dual-triode cathode-coupled stage, the

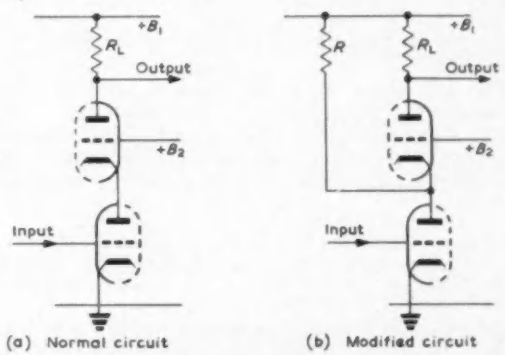


Fig. 1. Cascode amplifier circuits

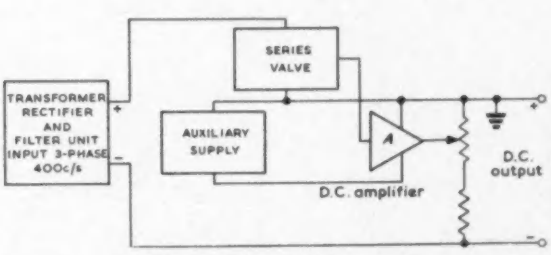


Fig. 2. Block diagram of power supply

desired output voltage polarity would be obtained. However, analysis (see Appendix) showed that a substantial decrease in gain would result if the cathode-coupled stage employed a type 12AX7 valve which was used in the original circuit. A valve which retained a high amplification factor, but had a much lower anode resistance, was indicated, and the type 12AT7 valve was chosen. Calculations using nominal values for valve constants gave an estimate of 1 200 for the gain, and the measured gain with an unselected pair of valves was found to be in excess of 1 300, with $R_L = 1M\Omega$. Loading of the amplifier by the series valve was not a problem, since the input resistance of the series valve at negative grid voltages exceeding −10V was found to be at least 12MΩ, and the maxi-

* *National Research Council, Canada.*

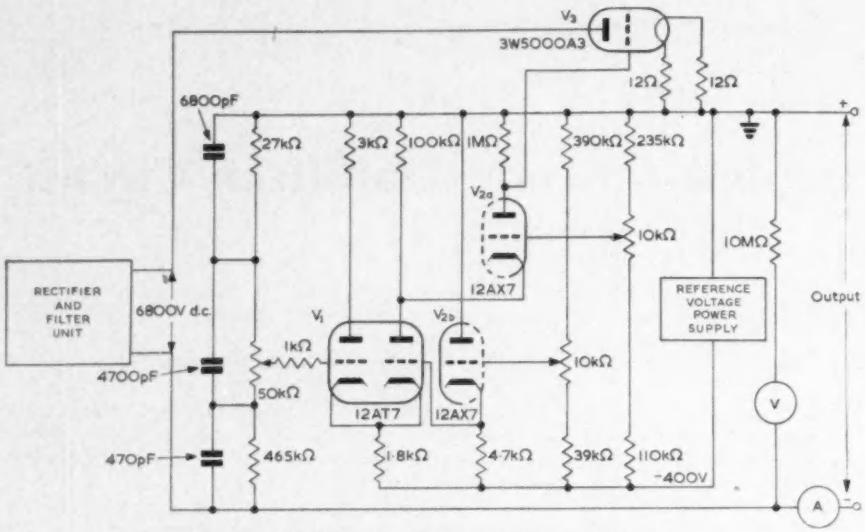


Fig. 3. Simplified schematic of regulated power supply

mum grid voltage during operation was expected to be about −25V.

Fig. 3 shows a simplified schematic diagram of the power supply. The input power was three-phase, 400c/s, and a full-wave bridge rectifier using series connected silicon diodes was followed by a single π-section filter. The nominal output was 6·8kV. The auxiliary supply used

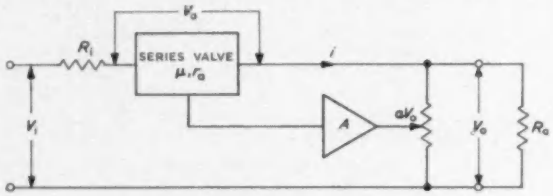


Fig. 4. Performance of degenerative stabilizer

$$V_i = R_i \cdot i + V_a + V_o$$
$$\Delta V_i = R_i \cdot \Delta i + \Delta V_a + \Delta V_o$$
$$\Delta V_a = r_a \cdot \Delta i - \mu \Delta V_g \qquad \Delta V_g = -(a\Delta V_o \cdot A)$$
$$\Delta V_i = (R_i + r_a)\Delta i + (1 + \mu aA)\Delta V_o$$

$$\text{Stabilization factor, } S = (\Delta V_o/\Delta V_i)_{\Delta i = 0} = \frac{1}{(1 + \mu aA)}$$

$$\text{Regulation, } R_a = (-\Delta V_o/\Delta i)_{\Delta V_i = 0} = \frac{R_i + r_a}{1 + \mu aA}$$

$$\text{Loop gain} = (\mu \cdot a \cdot A)$$

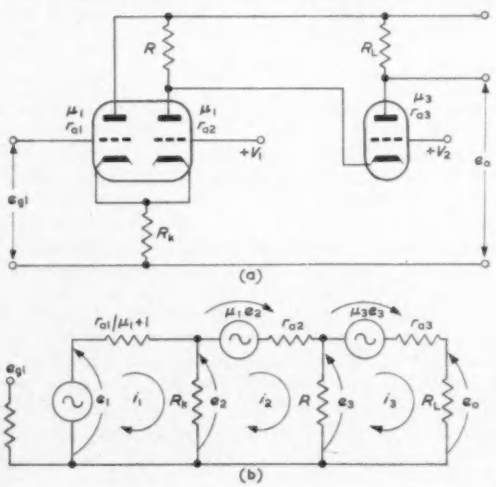
the Attree circuit, modified for an output of 400V. It served as both power supply for the amplifier and reference voltage source. The reference voltage was supplied from a resistive divider to the right-hand grid of the cathode-coupled stage by way of a cathode-follower, using the remaining half of the 12AX7. If the reference voltage was supplied directly from the resistive divider some loss of amplifier gain was observed.

Stabilizer Performance

The prime factor affecting the performance of a degenerative stabilizer is the net gain G_L of the stabilizer loop. Fig. 4 shows that the stabilization factor S (defined as the ratio of change in output voltage, ΔV_o, to the change in input voltage, ΔV_i, at constant current, i) is equal to $1/(1 + G_L)$. Also, the regulation, R_a (defined as the ratio of change in output voltage, ΔV_o, to the change in current, Δi, for constant input voltage, V_i) is $[(R_i + r_a)/(1 + G_L)]$, where R_i is the internal resistance of the unregulated supply and r_a is the anode resistance of the series valve. If variations in the unregulated voltage are considered to be locally-generated distortion in the amplitude reference voltage, the above expressions for S and R_a are similar to the familiar expressions for the reduction of distortion and of output impedance in feedback amplifiers. Like the feedback amplifier, the degenerative stabilizer can be unstable. The condition for stability is that G_L be less than unity at all frequencies for which the phase-shift around the loop exceeds 180°. One advantage of the stabilizer circuit described is that stability is achieved easily. This is because all of the circuit nodes except two are low impedance points, so that the inevitable shunt capacitances do not produce appreciable phase-shifts except at high frequencies. If the voltage divider which provides the sample of the output voltage is compensated, there remains only the load resistance of the amplifier, R_L, and its shunting capacitance to contribute significantly to loop phase-shift. The loop gain falls with increasing frequency above 1kc/s at a rate slightly in excess of 6dB/octave, and reaches unity with a considerable phase margin. If necessary, the roll-off frequency could be extended if the rate of attenuation were increased by suitable circuit changes.

Using resistive loads, a number of checks were made of stabilizer performance. The peak-to-peak ripple voltage was less than 1·5V over the range of output voltages and

Fig. 5. (a) Cathode-coupled cascode amplifier
(b) Equivalent circuit for low frequency variations



load currents of the supply. The change in output voltage for a ±10 per cent change in line voltage appeared to be well within the specified ±1V over the range of load currents. Specifically, near the mid-point in the output voltage and current ranges, variation of ±0·2V was recorded. However, the stability of the measuring apparatus was insufficient to allow measurements to a precision greater than a few parts in 10^4, so that it is possible to say only that the performance was of the order expected. Approximate measurements of output impedance in the range 30c/s to 10kc/s indicated a value of $5 \pm 2\Omega$. The expected value at d.c. was about 2Ω, and rough measurements indicate that a value less than 4Ω was achieved.

Conclusion

A high-performance negative supply in which stability was easily achieved has been described. The cathode-coupled cascode amplifier circuit was shown to have the advantages of simplicity, convenience, high gain and relatively low phase-shift for negative high-voltage stabilizer use.

APPENDIX

The cathode-coupled cascode amplifier and its equivalent circuit for low frequency variations are shown in Fig. 5.

$$e_1 = \left\{\frac{r_{a1}}{(\mu_1 + 1)} + R_k\right\} i_1 - R_k i_2 \quad \ldots\ldots\ldots\ldots\ldots (1)$$

$$e_1 = \frac{\mu_1}{(\mu_1 + 1)} e_{g1} \quad \ldots\ldots\ldots\ldots (1a)$$

$$e_2 (1 + \mu_1) = (r_{a2} + R)\, i_2 - i_3 R \quad \ldots\ldots\ldots (2)$$

$$e_3 = R_k (i_1 - i_2) \quad \ldots\ldots\ldots\ldots\ldots (2a)$$

$$e_3 (1 + \mu_3) = i_3 (r_{a3} + R_L) \quad \ldots\ldots\ldots\ldots (3)$$

$$e_3 = R (i_2 - i_3) \quad \ldots\ldots\ldots\ldots\ldots (3a)$$

The gain of the amplifier for low frequency variations,

$$A = e_o/e_{g1} = (i_3 . R_L/e_{g1}) \quad \ldots\ldots\ldots (4)$$

Solving equations (1) to (3) for i_3 and substituting in (4)

$$A = \frac{\mu_1 R_L}{\left[(r_{a1} + r_{a2}) + \dfrac{r_{a1} \cdot r_{a2}}{R_k(\mu_1 + 1)} + \dfrac{R_L + r_{a3}}{R(\mu_3 + 1)}\left\{r_{a1} + r_{a2} + R + r_{a1}\left(\dfrac{r_{a2} + R}{R_k(\mu_1 + 1)}\right)\right\}\right]}$$

If $\mu_1 = 60$ $\mu_3 = 90$ $r_{a1} = 10\text{k}\Omega$ $r_{a2} = 20\text{k}\Omega$
$r_{a3} = 120\text{k}\Omega$ $R = 100\text{k}\Omega$ $R_k = 1{\cdot}8\text{k}\Omega$ $R_L = 1\text{M}\Omega$

$$A \simeq \frac{60 \times 10^6}{49 \times 10^3} \simeq 1200$$

REFERENCE

1. ATTREE, V. H. A Cascode Amplifier Degenerative Stabilizer. *Electronic Engng.* 27, 174 (1955).

Ireland's Inland Microwave Telephone System

The first microwave radio link for trunk telephone transmission for the Department of Posts and Telegraphs, Ireland, has now been brought into service. The radio 'hops' are between Galway and Cappataggle and between there and Athlone. At Athlone, the radio link is connected to a coaxial cable to Dublin, the whole providing Galway—Dublin trunks.

The microwave radio system was supplied by Standard Telephones and Cables Limited to the requirements of the Department of Posts and Telegraphs; the coaxial cable system is an existing STC installation.

The equipment supplied includes 7 400Mc/s radio link equipment including aerial towers at the Galway and Athlone terminals and at the repeater station at Cappataggle, frequency multiplex equipment at the terminal, transmission test equipment, and machines for the standby power supply.

The 7 400Mc/s microwave system can handle 240 telephone circuits on each of 2 bothway radio-requency channels operating within the frequency band 7 300 to 7 400Mc/s for one direction of transmission and 7 400 to 7 500Mc/s for the other. One channel will be used as a standby channel. Both channels utilize the one set of aerials and aerial feeders for both directions of transmission. To effect channel changeover, automatic baseband switching is incorporated in the radio equipment.

The output of the telephone multiplex channelling equipment at the terminal passes to the baseband switching equipment, where it is combined with a pilot signal of 20kc/s. The composite signal is then transmitted simultaneously over the two r.f. channels, one acting as standby to the other. At the distant repeater or terminal the two paths pass to the switching equipment where the pilot levels are monitored. In the event of a failure in the first channel, the equipment switches over automatically at high speed and passes the signal to the next stage in the link, or to the receiver channelling equipment at the distant terminal.

This method of applying baseband switching to each section of the radio link ensures maximum reliability and flexibility in service. A simple remote supervisory system and visual indicator alarms to control the unattended repeater station are provided in the microwave system.

To carry the 8ft diameter parabolic reflector aerials, an 85ft high self-supporting tower has been erected on the roof of the terminal building at Galway, and a similar tower, 120ft high, beside the building at Athlone. For the repeater at Cappataggle a guyed mast 150ft high has been built alongside the radio equipment building.

The microwave antenna tower at Athlone. The large paraboloid reflector (8ft diameter) at the top of the tower handles transmission and reception on the new link. The smaller reflectors are for the temporary link

V.H.F. Broad-Band Variable Group-Delay Equalizers

By R. Hamer*, B.Sc., Ph.D., A.M.I.E.E., and R. G. Wilkinson†

A method of providing continuously variable group-delay/frequency characteristics in a broad-band v.h.f. transmission path is described. The application of the principle to the design of variable group-delay equalizers is explained, and two such instruments are described suitable for use in the 70Mc/s intermediate-frequency sections of microwave radio systems employing frequency modulation.

The first model is for use in multi-channel telephony links for up to 960 channels or 405-line sub-carrier colour television links: the second is suitable for 1 800-channel telephony or 625-line sub-carrier colour television.

(Voir page 547 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 554)

IN the transmission of complex signals over frequency-modulation radio-relay systems, small departures from uniformity in the group-delay/frequency characteristic can give rise to serious signal distortion. Even when the best available techniques are used in the design and alignment of the component parts, the cumulative group-delay distortion in a long microwave radio system is usually too large for the satisfactory transmission of frequency-division multiplex telephony signals of 600 or more channels. Troubles due to excessive group-delay distortion are also likely to occur in the transmission of sub-carrier colour-television signals.

The group-delay distortion in microwave radio links is of three principal types:

(a) Smooth, comparatively low-order curves and slopes due to the transfer characteristics of amplifiers and filters.

(b) Sinusoidal ripples due to echo-signals.

(c) Kinks, steps and similar discontinuities due to spurious resonances or unwanted feedback in amplifiers.

It is common practice to use fixed equalizers to correct for distortions of type (a); types (b) and (c) should be removed by improved link design, and, in any case, are not usually sufficiently stable to be satisfactorily equalized. Feeder echoes may produce stable distortion of type (c), but this can be corrected if necessary by the inclusion of a counter-echo‡ in the i.f. signal path.

In a high grade radio system the amplifiers and filters are designed to have uniform group-delay characteristics over the required transmission band. However, at the end of a long relay system the residual group-delay variation might be several nanoseconds over a band of 20 to 30Mc/s, and, if not corrected, this would give rise to significant intermodulation distortion. With small group-delay non-uniformities of this type, it is permissible to regard the variation as a quadratic function of relative frequency, i.e. as a combination of linear slope and parabolic curvature. On this basis adequate correction is obtained by the use of bridged-T group-delay equalizers (tuned to midband or slightly offset) in the i.f. signal path: adequate, that is, provided the overall group-delay transmission characteristic does not change. Unfortunately, the characteristic is subject to variation throughout the working life of the radio system, due to component ageing and the replacement of faulty equipment; moreover, group-delay equalizing networks cannot be readily re-adjusted. The variable group-delay equalizers to be described offer a solution to this problem.

The equalizers have been designed to provide:

(a) Variable group-delay slope, positive or negative; and, since the parabolic curvature of practical networks is almost always positive.

(b) Variable, approximately parabolic, negative curvature, i.e. with maximum delay at the midband frequency.

The equalizers operate at the standard i.f. of 70Mc/s, and, with a view to the possible use of automatic group-delay correction in more advanced radio systems, voltage-control has been a design aim. Two equalizers have been designed: the first is for use in 600-channel telephony systems, or in the transmission of sub-carrier colour television signals of 405-line standard; the second is for 1 800-channel telephony or colour television based on 625-line standards. The first model has been briefly described previously[1].

Principle of Operation

The principle of operation[2] may be understood from the simplified block diagram in Fig. 1. The input power is divided equally into two branches by a splitting pad, and fixed group-delay equalizers, A, B, are placed in each branch. It is shown in the Appendix that provided certain requirements are met, the overall group-delay characteristic may be varied continuously between the limits set by the fixed equalizers by differentially combining the output signals from the two branches. This may be carried out by inserting two amplifiers, A, B, in the branches as shown, and controlling their gains differentially. The required output signal is taken from a combining circuit following the two amplifiers. The

* *Post Office Engineering Department.*

† *Admiralty Air Service Calibration Centre.*

‡ *i.e. an echo arranged to produce an equal-amplitude counter-phased group-delay ripple.*

particular requirements for obtaining a smooth transition between the fixed group-delay characteristics, while maintaining a substantially uniform amplitude/frequency characteristic, are as follows:—

(a) The group-delay at the midband frequency must be approximately the same in each branch, between the dividing and re-combining points.

(b) The two signal-voltage vectors at the combining point must be in phase at the midband frequency.

(c) The phase-angle between the signal-voltage vectors at the combining point must be small at all frequencies in the required transmission band.

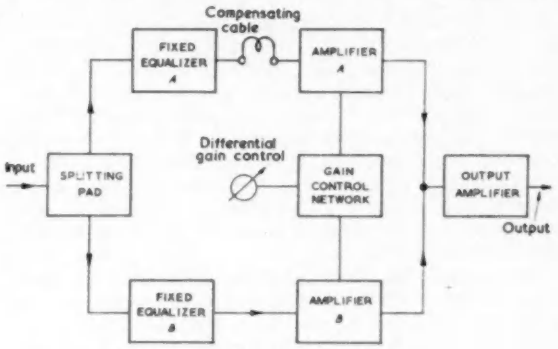


Fig. 1. Basic functional diagram

The first two conditions may be realized by placing a cable of selected length in the branch having the smaller delay. The length is first chosen to provide approximately equal delays, then its precise value (normally within a few inches) is chosen to equalize the phase-angles. The second condition is found to be more critical than the first. However, equality of delays at midband is important, since a delay difference implies a change in the relative phase of the two signals as the frequency departs from midband, and thus conflicts with the third requirement. Assuming good delay matching at midband, the maximum intentional group-delay variation in a given band is determined by the third requirement; the necessarily different group-delay characteristics of the two branches lead ultimately to excessive phase departures as the frequency relative to midband is increased. A maximum intentional variation of about 20nsec over a 20Mc/s band, with correspondingly greater variations for smaller bandwidths, represents the order of the limitation encountered in practice.

Design for 600-Channel Telephony

General Description

The variable equalizer for use in 600-channel telephony systems comprises two of the basic circuits described, in tandem, as shown in Fig. 2. The input and output impedances are 75Ω, coaxial, and the amplifying stages are arranged to provide zero-loss overall transmission. Six pentode valves, type CV3998 (E180F), are used, and the gain of each of the two voltage-amplifying pairs is controlled differentially by a potentiometer in each grid-cathode circuit.

The fixed group-delay equalizers are composed of bridged-T, all-pass networks of the type shown in Fig. 3. The slope equalizers each comprise two identical networks in tandem, detuned high for the positive slope and low for the negative slope. One network only, tuned to 70Mc/s, is used for the approximately parabolic characteristic. The equalizer networks are fully specified by the values of R_o, f_o and m. R_o is the characteristic resistance, f_o is the reference frequency and m is the ratio $\sqrt{(L_2/L_1)}$ (see Fig. 3). The reference frequency is the resonant frequency of:

(a) The parallel tuned circuit remaining in the series arm when the shunt inductor is disconnected.

(b) The series tuned circuit remaining in the shunt arm when the series inductor is short-circuited.

The equalizer sections used are specified in this way in Table 1.

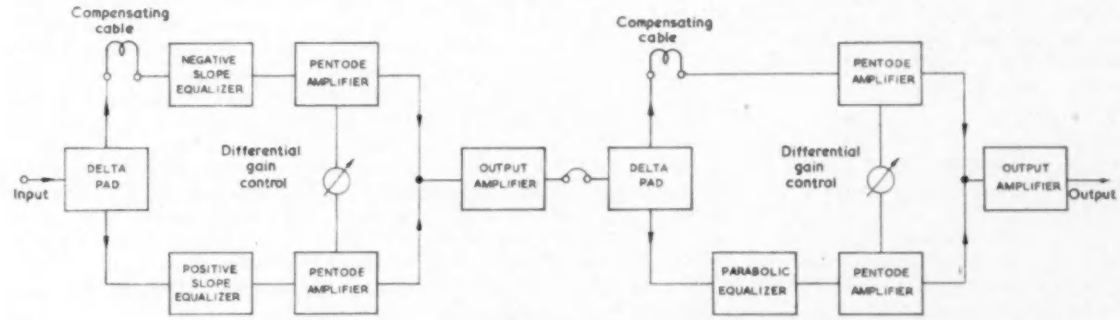


Fig. 2. The first variable equalizer

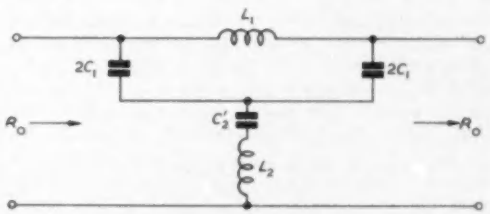


Fig. 3. Basic group-delay equalizer network

TABLE 1

Fixed Equalizer Networks (First Model)

NETWORK	$R_o(\Omega)$	f_o(Mc/s)	m
Positive slope	75	87	1·0
Negative slope	75	61	0·8
Curvature	180	70	1·75

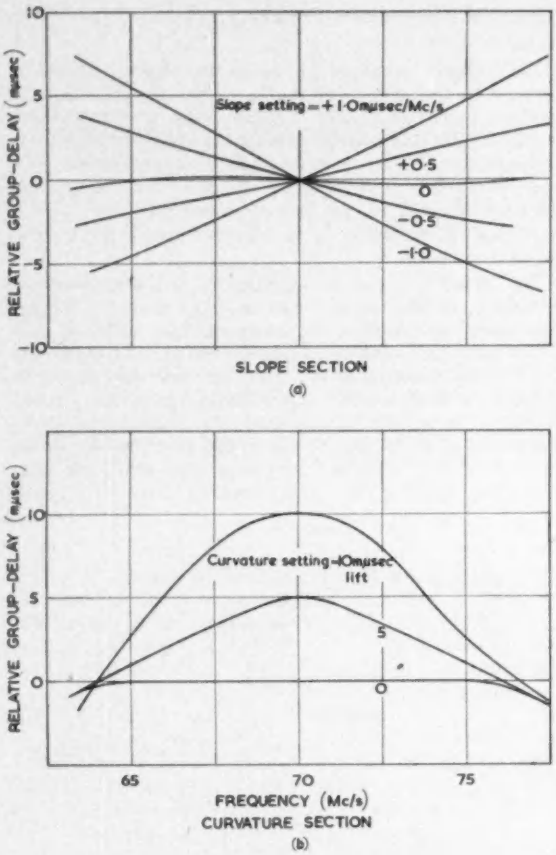


Fig. 4. Typical measured characteristics: first model

The action of the variable equalizer is seriously affected if echo-signals in one branch enter the other branch with appreciable amplitude. The isolating attenuation of 6dB provided by the delta-pads (see Fig. 2) is found to be inadequate; additional pads of about 6dB are required preceding the equalizer networks (or compensating cables) in each branch.

The controls for slope and curvature adjustment are accessible on the front panel of the instrument. The slope control is calibrated in nanoseconds per megacycle/second and the curvature in nanoseconds lift at 70Mc/s relative to 64 and 76 Mc/s.

Performance

Measured group-delay transmission characteristics are shown separately for each section of the variable equalizer in Fig. 4. Maximum slopes of $\pm$1nsec/Mc/s are obtained with reasonably good linearity, and the zero-slope setting provides a sufficiently uniform characteristic for the most exacting requirements. The second section provides a maximum lift of about 10nsec over a design bandwidth of 12Mc/s, and the zero-curvature setting again provides a uniform characteristic within close limits. The panel controls provide a smooth transition between the selected characteristcs shown. Some slight asymmetry arises in the parabolic characteristic near the maximum setting, but this is not a serious limitation, since it is readily corrected by the slope control. The slope is calibrated with zero curvature applied, an error of about 0·1nsec/Mc/s arising when maximum curvature is applied.

Outside the design band, the group-delay characteristics gradually level out and then, at frequencies greater than about 10Mc/s relative to midband, the characteristics rise fairly symmetrically due to the band-pass networks.

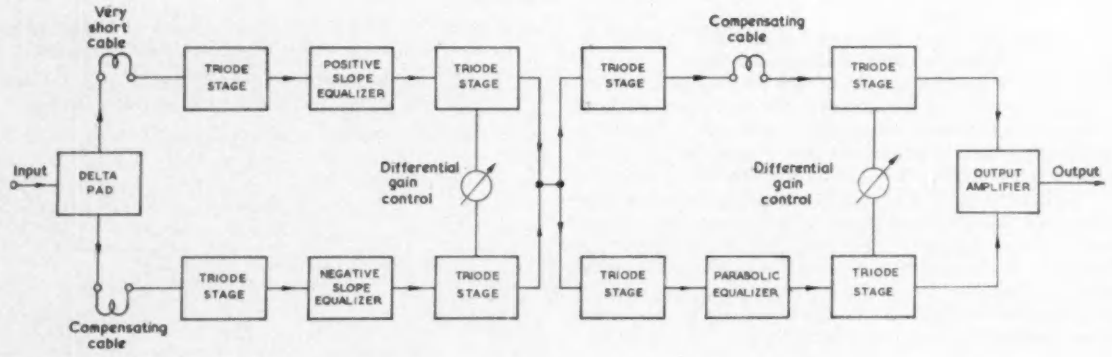
The amplifying stages are of the maximally-flat type, with an overall bandwidth to $-$1dB of 40Mc/s, and contribute negligible amplitude or group-delay variation over the band 64 to 76Mc/s. The bandwidth is modified by the equalizer networks and by the bi-path action; in particular, a cancellation of the branch voltages occurs at about 45Mc/s at the worst control setting. The transmission band, to $-$1dB, is then restricted to 53 to 89Mc/s, which is still more than adequate.

Slight undulations in the amplitude characteristic occur as the controls are varied, due to some imperfections in the equalizer networks and to residual echoes. The maximum variation over the design band of 12Mc/s is 1dB, but at most control settings it does not exceed 0·3dB.

Some variation of midband gain occurs as the controls are adjusted, but this can be reduced to any arbitrary value by elaboration of the gain controlling network and by selection of the controlled valves. In the present model the variation is within the range +1 to $-$2dB.

Some small variation of mean delay occurs with adjust-

Fig. 5. The second variable equalizer



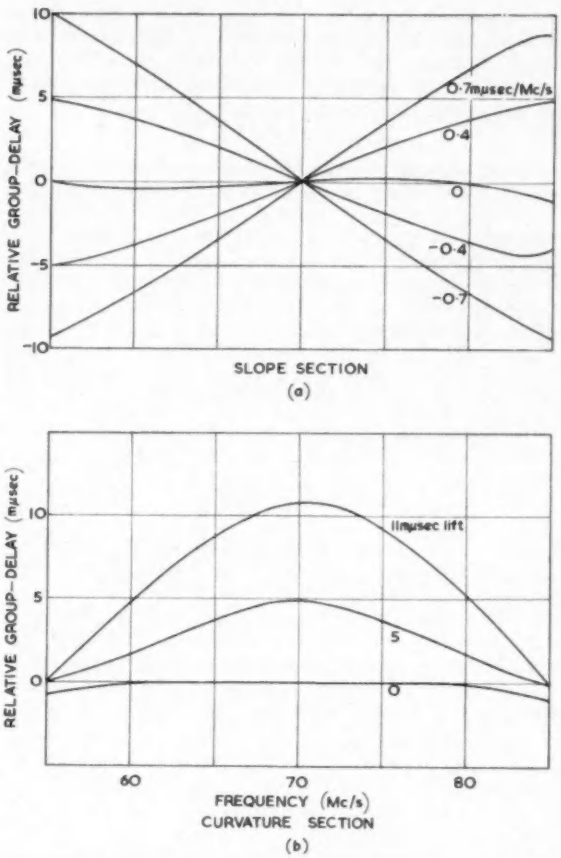


Fig. 6. Typical measured characteristics; second model

ment of the controls, but this is unimportant in the intended applications.

Transmission tests have been carried out using random-noise modulation to simulate a multi-channel telephony signal[3], with a 70Mc/s f.m. carrier. The performance of the equalizer has been found to be satisfactory not only in simulated 600-channel but also in 960-channel transmission. With 600-channel loading (white noise band of 60kc/s to 2·54Mc/s; r.m.s. frequency deviation of 0·87Mc/s*) the limiting noise power ratio due to the imperfections inherent in the variable equalizer is about 60dB. With 960-channel loading (noise band of 60kc/s to 4·08Mc/s; r.m.s. deviation of 1·1Mc/s) the limiting n.p.r. is about 55dB.

It may be concluded from the transmission characteristics and random-noise tests that the variable equalizer would also be satisfactory for the transmission of f.m. signals bearing 405-line sub-carrier colour television modulation.

TABLE 2

Fixed Equalizer Networks (Second Model)

NETWORK	$R_0(\Omega)$	f_0(Mc/s)	m
Positive slope	75	93	0·95
Negative slope	75	55	0·8
Curvature	75	70	1·2

* *200kc/s r.m.s. deviation per telephone channel.*

Design for 1 800-Channel Telephony

General Description

The broader-band model of the variable equalizer also comprises two of the basic circuits in tandem but, owing to increased difficulty in impedance matching, the fixed equalizer networks are now isolated between valves (Fig. 5). The networks are, however, of low impedance as a practical design feature, and high-slope triode valves (type R5559) are used to provide zero-loss transmission. The input and output impedances are again 75Ω, coaxial, and a pentode valve (type CV3998) drives the load through a broad-band transformer. A novel feature of the design is the use of low-pass filter networks at the input and between valves; these have cut-off frequencies of about 120Mc/s and provide extremely good matching (constant resistive impedances) over a design band of 55 to 85Mc/s.

A single bridged-*T* network is used in each fixed slope equalizer; the design parameters of these two networks and the curvature network are specified in Table 2.

Although slightly better linearity would be obtained by the use of two networks in each slope equalizer, the circuit alignment for accurate broad-band matching would then be too critical.

The separate slope and curvature controls appear on the front panel, as in the first model, and the dial calibration is similar; the curvature is shown as lift at 70Mc/s relative to 55 and 85Mc/s.

Performance

Typical measured group-delay transmission characteristics are shown in Fig. 6. The maximum variation of group-delay provided is about 10nsec, as in the first model, but this now occurs over a 30Mc/s band. The maximum amplitude/frequency variation over this transmission band is 1dB, but at most control settings it does not exceed about 0·5dB. The overall bandwidth to −1dB is not greatly affected by the control settings, and is about 40Mc/s centred on 70Mc/s. Outside the design band of 30Mc/s the group-delay characteristics level out and subsequently rise, as in the first model.

The performance of the variable equalizer is in other respects similar to that of the first model. Random-noise tests have shown that the device is satisfactory for use in 1 800-channel telephony systems. With a white noise band of 312kc/s to 8Mc/s and a r.m.s. frequency deviation of 1·06Mc/s† the limiting n.p.r. due to the variable equalizer is about 55dB.

It may be concluded from the transmission characteristics and random-noise tests that the second variable equalizer would be satisfactory for 625-line sub-carrier colour television signals.

Discussion

Although the variable group-delay equalizers described were designed for possible use in f.m. trunk radio systems, they have already proved to be useful laboratory tools. When used in conjunction with random-noise testing, a variable equalizer offers a rapid means of assessing the group-delay distortion in the signal path. The control settings required to give the optimum n.p.r. at the highest baseband frequency give an immediate indication of the transmission group-delay characteristic. Furthermore, the effective group-delay characteristic of discriminator circuits can often be more readily assessed in this way.

† *140kc/s r.m.s. deviation per telephone channel.*

The voltage-control feature of the designs described renders feasible closed-loop automatic group-delay correction systems. One such system, making use of the first equalizer, has recently been described[4].

Acknowledgments

The permission of the Engineer-in-Chief of the Post Office to publish this article is gratefully acknowledged.

Appendix

Theoretical Analysis

Referring to Fig. 1, let the output voltages at the combining point be r_1V due to branch A and r_2V due to branch B. The factors r_1, r_2 are variable differentially, such that,

$$r_1 + r_2 = r_o$$

where r_o is a constant. The losses and amplifier gains occurring may conveniently be included in r_1, r_2, r_o, so that if there is no relative phase-shift through the two branches the output voltage is r_oV. It is assumed that the amplitude/frequency characteristic over the frequency band of interest is uniform via either branch.

Let the group-delay/frequency characteristics of the fixed equalizer networks A, B, be represented by:

$$T_A = T_1(x)$$
$$T_B = T_2(x)$$

where x is the angular frequency relative to the midband angular frequency, ω_o, i.e. $x = \omega - \omega_o$. The phase characteristics of the two branches are then:

$$\phi_1 = \int T_1(x)\,dx + \psi_1 \quad \ldots\ldots\ldots (1)$$

$$\phi_2 = \int T_2(x)\,dx + \psi_2 \quad \ldots\ldots\ldots (2)$$

where ψ_1 and ψ_2 are the phase-angles of the output voltage vectors from each branch relative to the input voltage vector, at the midband frequency. The output voltage, V_o, is the vector sum of the branch voltages; thus,

$$V_o^2 = V^2[r_1^2 + r_2^2 + 2r_1r_2\cos(\phi_1 - \phi_2)] \quad \ldots. (3)$$

This is the equation of the resultant amplitude transfer characteristic, and it may readily be shown that the function is least uniform, representing the worst practical case, when

$$r_1 = r_2 = \tfrac{1}{2}r_o$$

The characteristic then becomes, using equations (1) and (2):

$$V_o = r_oV\cos\tfrac{1}{2}\left[\int(T_1(x) - T_2(x))dx + \psi_1 - \psi_2\right] \quad \ldots\ldots\ldots (4)$$

The worst amplitude/frequency characteristics encountered in a particular case is given by equation (4) with the appropriate functions $T_1(x)$ and $T_2(x)$ inserted. Thus, for the linear slope equalizer, for example,

$$T_1(x) = t_A + t_1x$$
$$T_2(x) = t_B + t_2x$$

Equation (4) then becomes:

$$V_o = r_o\,V\cos\tfrac{1}{2}[\tfrac{1}{2}(t_1 + t_2)\,x^2 + (t_A - t_B)\,x + \psi_1 - \psi_2] \quad .. (5)$$

The orders of magnitude of the terms in the cosine are normally such that the term in x may be neglected, particularly since t_A and t_B may be made approximately equal by selecting the midband delays in the two branches. The value of $(\psi_1 - \psi_2)$ may be very large, so if a nearly uniform amplitude characteristic is required it is necessary to make this term a multiple of 2π. This implies bringing the two branch voltages into phase at the midband frequency, for example by careful choice of compensating cable length. When these conditions apply, and assuming that $t_2 = -t_1$,

$$V_o = r_o\,V\cos\tfrac{1}{2}\,t_1\,x^2 \quad \ldots\ldots\ldots (6)$$

As an example, consider a slope equalizer providing a maximum variation of 20nsec over a 10Mc/s band. The angle in the cosine of equation (6) then varies between the limits of $\pm\pi/20$ in the worst case considered. The cosine therefore varies between unity at midband and 0·988 at the edges, corresponding to an amplitude variation of 0·1dB. Similar results are obtained when a parabolic group-delay function is combined with a uniform characteristic. It may be shown that for a 10nsec maximum variation over a 10Mc/s band the worst amplitude characteristic has a variation of only 0·01dB.

It follows from a vector diagram of the two branch output voltages, $r_1V\angle\phi_1$ and $r_2V\angle\phi_2$, that:

$$\frac{V_o}{\sin(\phi_1 - \phi_2)} = \frac{r_1V}{\sin(\phi - \phi_2)}$$

where ϕ is the phase of the resultant relative to that of the input voltage. As has been seen, the amplitude variation with correct design is very small over the required frequency band, hence V_o may be replaced by r_oV with negligible error. If the analysis is confined to the case where $(\phi_1 - \phi_2)$ is always very small (the third design requirement listed under 'Principle of Operation') then, since $(\phi - \phi_2)$ is in consequence also very small,

$$\frac{r_o}{\phi_1 - \phi_2} = \frac{r_1}{\phi - \phi_2}$$

Hence,

$$\phi = (r_1/r_o)\,\phi_1 + (r_2/r_o)\,\phi_2 \quad \ldots\ldots\ldots (7)$$

For any given values of r_1 and r_2 the factors r_1/r_o and r_2/r_o are independent of frequency, consequently by differentiating (7) with respect to x the overall group-delay becomes

$$T = (r_1/r_o)\,T_1(x) + (r_2/r_o)\,T_2(x) \quad \ldots\ldots\ldots 8)$$

Equation (8) shows that, subject to the approximations made, the overall group-delay transfer characteristic is the addition of the branch characteristics taken in the proportions $r_1 : r_2$. The result is based on the assumption that the amplitude characteristic is substantially uniform, necessitating, as shown, the correct choice of compensating cable length and a sufficiently small maximum group-delay variation over the required frequency band. The midband group-delays in the two branches need not be precisely equal, but, if they are not, the phase difference $(\phi_1 - \phi_2)$ increases more rapidly with frequency departure from midband. Also, if the midband delays are not equal, variation of the ratio r_1/r_2 causes a change in the overall midband delay, due to a constant term in either $T_1(x)$ or $T_2(x)$ in equation (8). A smooth change in mean delay occurs as the ratio r_1/r_2 is varied, and, although this effect is unimportant here, it may have useful applications elsewhere.

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The Operation of Transistors in the Avalanche Mode

By M. J. Duckenfield*, B.Sc.(Eng.)

The well defined collector voltage of a saturated transistor enables simple circuits to be used for producing pulse and rectangular waveforms. Operated in the avalanche mode transistors are capable of producing waveforms with very fast rise-times and peak powers of the order of 5W. Some empirical results obtained by such operation are given together with details of the circuits used.

(Voir page 547 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 554)

EARLY in 1960 the requirement arose for a generator capable of producing pulses with peak currents of over 1A in a low resistance load. Fast rise-times were required with repetition rates of several kilocycles per second. It was decided to investigate the possibility of using avalanche transistors as the output device. The investigation was carried out empirically, avalanche circuits being tested with different transistors and component values, and under different conditions of input driving impedance. Before proceeding to the results, a brief introduction is given to the avalanche mode of operating a transistor.

Avalanche Operation

In avalanche operation the potential gradient across the transistor is made large by using comparatively high voltage supplies (e.g. 100V). This results in a 'breakdown' of the semiconductor material and the transistor operates in an abnormal manner. The high field strength causes current carriers injected into the base to accelerate very rapidly across the collector depletion layer and by collisions with the lattice structure, other carriers, which are normally too tightly bound to be moved, are released. Thus an 'avalanche' effect is produced and current multiplication takes place, allowing a much larger current than normal to flow through the transistor. In fact the transistor acts as if its grounded base current gain (α) was much greater than unity[1], resulting in a very rapid increase in collector current.

Fig. 1 shows a typical curve[1] obtained by plotting values of collector current I_c against collector to base volts V_{cb}. The avalanche breakdown voltage is normally between 25 and 50V. This breakdown voltage affects the amplitude of the output pulse obtainable and varies between transistors. To determine the breakdown voltage experimentally a high value resistance is connected between the collector of the transistor and a supply voltage V_s which is gradually increased. A curve of V_{cb} against V_s can then be plotted, as in Fig. 2, to determine the breakdown voltage.

The values of collector resistance and maximum supply voltage are suitably chosen to limit the standing current and hence the collector dissipation during the experiment. Thus:

$$I_{st} = W_c/V_c \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

and if R_c is the value of the collector resistance:

$$I_{st} = \frac{V_s - V_c}{R_c} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where I_{st} = standing current.

A convenient value for R_c is 100kΩ, which for a supply of 150V and a transistor with a breakdown voltage of 30V allows a standing current of 1·2mA, from equation (2). The collector dissipation is then 36mW.

Both pnp and npn transistors can be used in avalanche circuits, the npn having a slightly higher breakdown voltage than the pnp[2]. However it is often possible to alter the effective breakdown voltage by suitably biasing the transistor[3] and Fig. 3 shows the collector voltage/supply voltage graph for an OC24 under two different bias conditions.

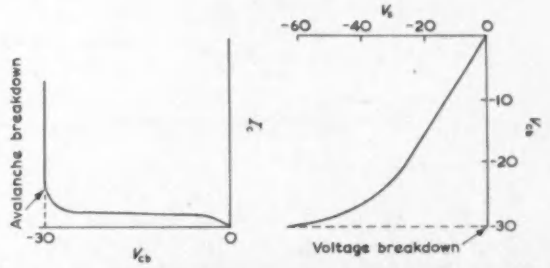

Fig. 1. (left) Collector current/base voltage characteristics showing rapid current rise due to the avalanche effect

Fig. 2. (right) Collector voltage/supply voltage characteristic, plotted for a h.f. power transistor

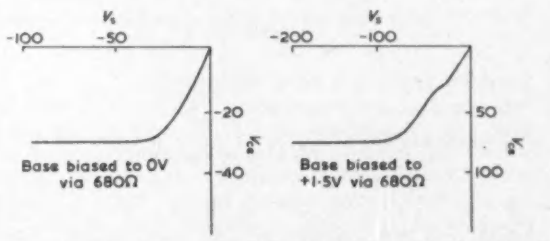

Fig. 3. Typical collector voltage/supply voltage characteristics showing effect of base bias

The base circuit arrangement affects the speed of switching[3] and for the fastest 'turn on' a separate base bias supply must be provided.

Avalanche Circuit Arrangement

If triggered operation is required the transistor base is biased 'off', the collector resting at its breakdown potential. If the transistor is a pnp type a negative potential must be applied to the base to trigger the transistor into operation. The basic circuit is shown in Fig. 4, together with a typical collector waveform. To obtain large currents the load resistance R_L is a low value (e.g. 10). It is coupled to the transistor by a capacitor C as shown.

* *The National Physical Laboratory*

Effect of Variables

Transistors

Transistors for use in the avalanche mode should have the highest values of cut-off frequency and current gain obtainable. In practice transistors with a value of f_α greater than about 3Mc/s and with β greater than 40 yield good results. To obtain maximum output a high value of breakdown voltage is necessary, but to prevent too high a rejection rate the circuit design should accommodate transistors with some arbitrary lower breakdown voltage, e.g. 30V. The transistors thus selected should be tested in an avalanche circuit, since some may not avalanche and others may oscillate. Chaplin[1] tabulates accepted/rejected numbers which suggest that in many cases only 1 in 2 will be satisfactory for avalanche operation. Results in this investigation indicate that the ratio depends very much on the particular batch of transistors. Thus one batch of GT13's (now GT43) yielded 2 in 3 acceptable, while a small batch of GT43's gave about 1 in 5 acceptable. The OC44's tried have shown less variation, but over a small number of samples only about 1 in 2 have been accepted.

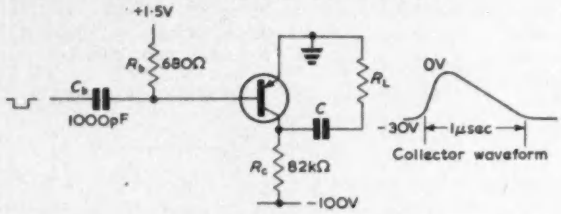

Fig. 4. Typical avalanche circuit details

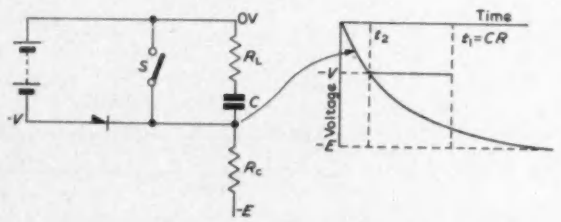

Fig. 5. Idealized representation of avalanche circuit when the transistor is conducting

Supply Voltage and Repetition Rate

In the example given earlier a supply of −150V was used with a transistor having a breakdown voltage of −30V. The supply need only be sufficiently greater than the breakdown voltage to permit a small standing current to flow through the collector resistor, but the speed of switching increases with an increase in V_s of about 100 per cent above the minimum for a given collector resistance. Further increase in supply voltage has little effect on switching speed. It must be remembered, as detailed earlier, that the bias may affect the breakdown potential and the value of V_s must allow for this. For the OC24 with +1½V of bias of which the breakdown curve was given earlier, a −180V supply with $R_c = 50k\Omega$ was necessary to obtain good switching, though the coupling capacitor has to recharge via this resistance which therefore affects the repetition rate. Values used with OC44 and similar transistors are −100V or −150V supply and 82kΩ or 120kΩ collector resistances, which allows for the spread in collector breakdown voltage.

The effect of variations in the above conditions can be seen from the following analysis. The transistor, when 'off', can be considered as a battery and diode which when biased forward becomes a voltage source, and when 'on', as a short-circuit—see Fig. 5. The switch represents the 'on' condition and so is closed. When it is opened (i.e. the transistor is switched off), C commences recharging, with a time-constant of CR seconds, to $-E$ volts, but when the collector potential is sufficiently negative breakdown occurs and it clamps the potential of C at $-V$ volts, represented by the action of the diode. The time-constant with no clamping is CR seconds, and t_2 is a proportion of CR given by:

$$t_2 = CR \ln \frac{E}{E - V} \text{ and if } K = V/E, \; t_2 = CR \ln \frac{1}{1 - K}$$

Thus to recharge quickly, $-E$ should be much more negative than $-V$, but provided $-V$ is less than about $\frac{1}{4} \times -E$ any change in recharge time is not significant. Also although a smaller value of $-V$ for a given value of $-E$ enables a faster repetition rate to be achieved, as mentioned earlier it reduces the output pulse amplitude.

As an example, a ·002μF capacitor recharging to 25V via a 100kΩ resistor with 150V supply will take:

$$t_2 = CR \ln \frac{1}{1 - K}$$

$$= CR \ln \frac{1}{1 - (25/150)}$$

$$\therefore \; t_2 \simeq 002 \times 10^{-6} \times 100 \times 10^3 \times 0{\cdot}18$$

$$= 36\mu\text{sec}$$

Hence the maximum repetition rate is 28kc/s.

Source Impedance

The switching time is dependent on the trigger source and to obtain fast rise-times a large input voltage or a low a.c. source impedance is necessary. In an experiment to ascertain the magnitude of this effect the drive impedance and voltage were altered and the collector rise-times noted, with the approximate results shown in Table 1. The transistor used was an OC44 with a breakdown voltage of −32V.

TABLE 1

TRIGGER IMPEDANCE	TRIGGER VOLTAGE	COLLECTOR RISE-TIME (mμsec)
600	15	400
300	15	270
300	5	580
150	5	530
100	5	420
75	5	300
150	10	260

R_b = 680Ω
C_b = 2200pF
C_c = 3200pF
R_L = 10Ω

Modifying the base circuit values will also modify the rise-time and better results could probably be obtained.

If the transistor is overdriven saturation occurs and hole storage limits the maximum repetition rate, resulting in the collector waveform shown in Fig. 6.

Fig. 6. The effect of hole storage on the collector waveform

Alternatively, if the transistor is not driven hard enough, the collector may never reach 0V, reducing the output pulse amplitude and losing the voltage definition achieved by the transistor bottoming.

Results

The results obtained varied widely with component values and the type of transistor used, as may be seen from Table 2. This Table gives a guide to the performance that can be expected from different transistors.

If the fastest possible rise-time is required, the current pulse passed by the transistor must be kept small. This may be achieved by using a small value coupling capacitor, e.g. 5pF and rise-times of the order of 5mμsec can then be expected[1]. No tests were made using low values of C.

The oscilloscopes used for measurement were a Solarscope CD711S and a Tektronix 517.

TABLE 2

TRANSISTOR (nominal values) of f_α and β	H.T. VOLTAGE (V)	R_L (Ω)	C (pF)	RISE-TIME (mμsec)	PULSE LENGTH (mμsec)	PEAK AMPLITUDE (V)	PEAK LOAD CURRENT (mA)
OC44	−150	100	47	30	100	2	20
f_α = 15Mc/s		100	1000	50	500	15	150
β = 100		100	3200	70	1100	20	200
and GT43							
f_α = 9Mc/s		50	3200	60	1100	14	280
β = 100		10	3200	50	300	4·2	420
V6/8R	−150	10	3200	30	200	12	1200
f_α = 10Mc/s							
β = 80							
TK24B	−150	10	3200	50	800	3	300
f_α = 2.5Mc/s							
β = 35							

$R_b = 680\Omega$ $V_b = 1\frac{1}{2}V$ $R_e = 100k\Omega$ $C_b = 2200pF$ Trigger source 5V, 100Ω

TABLE 3

H.T.	R_C (kΩ)	R_L (Ω)	PEAK LOAD CURRENT (mA)	RISE TIME (mμsec)
185	100	100	300	200
185	100	10	480	200
185	50	100	380	180
185	50	10	1100	90
185	50	2	2200	60
120	50	10	450	180

$C = 3200pF$
$R_b = 680\Omega$
$V_{bias} = +1\frac{1}{2}V$

The pulse length with the 2 Ω load was 200mμsec

Power Transistors

The use of power transistors in the avalanche mode increases the possible dissipation and hence the possible power drain, and also may allow a higher repetition rate due to this. But most of them suffer from low values of f_α and β, giving a poor rise-time. However, the OC24 has an f_α of 2·5Mc/s and can give a rise- time of about 60mμsec. The results in Table 3 were obtained driving the OC24 from an npn avalanche circuit.

Free Running Condition

If the applied base potential of an avalanche transistor does not hold the transistor 'off' free running will occur. While it now acts as a generator of fast pulses, the value of such a simple circuit is offset by the very ill-defined limits of the collector waveform.

Practical Driving Sources

A low power transistor multivibrator will not drive an avalanche circuit, an emitter follower interposed between the two being necessary to obtain a sufficiently low source impedance. The invertor circuit[4], Fig. 7, may be used to operate both pnp and npn avalanche transistors from a single source, since it will supply fast positive and negative edges. The invertor circuit shown in Fig. 7 has an a.c. output impedance of less than 100Ω and will supply 12V square waves with good edges. Thus the combination of an invertor circuit driving a pnp and npn avalanche transistor in parallel enables a generator supplying fast positive and negative pulses to be simply designed.

The Future

Transistors specially designed for avalanche operation will lead to more accurately designable circuits and better performance. At present a transistor rated at over 60V emitter/collector potential and with a value of f_α greater than 15Mc/s would enable improved avalanche circuits to be designed.

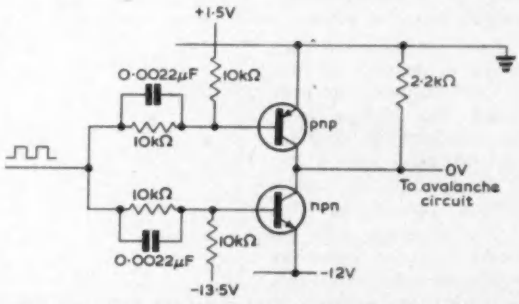

Fig. 7. The invertor circuit as used to drive combined avalanche transistor circuits

Acknowledgments

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The Main Store of a Digital Differential Analyser

By P. L. Owen*, B.A., M. F. Partridge*, M.A., and T. R. H. Sizer*, A.M.I.E.E.

This article, the second of a series of four describing the elements of a transistorized digital differential analyser, deals with the main store. The store consists of a 50 word by 32 digit matrix of ferrite cores. The function of each of the components into which the storage loop may be logically divided is described in detail.

(Voir page 547 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 554)

THIS article is the second in a series which describe some of the circuit elements of CORSAIR[1], a fifty integrator digital differential analyser. The contents of this article will be of interest in that they describe the design of a complete storage loop and its interpretation in practical form.

The core store and its read and write circuits occupy the uppermost two trays in a standard three-panel 19in cabinet. There are six trays in all, interconnected by means of plugs and sockets so that each may be withdrawn as a separate unit. All the circuit elements are accommodated on printed wiring boards 4½in by 4½in.

Each section of this article is devoted to one of the components into which the storage loop may be logically divided. The complete loop is depicted in Fig. 1(a) and a general view in Fig. 1(b).

The elements will be treated in the order in which the signal circulates through them, namely, from the core store via the read amplifiers to the shift registers. After passing as a serial word through an arithmetic unit, information is returned via the shift registers to a buffer store and finally returns to the core store by means of the digit write circuits.

Before proceeding with the main descriptive material sufficient details of the working of the machine as a whole are given to enable the function of the store to be appreciated in its true context.

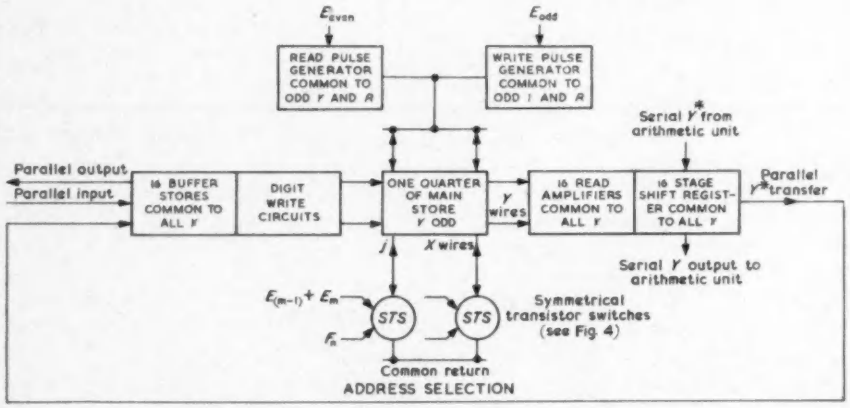
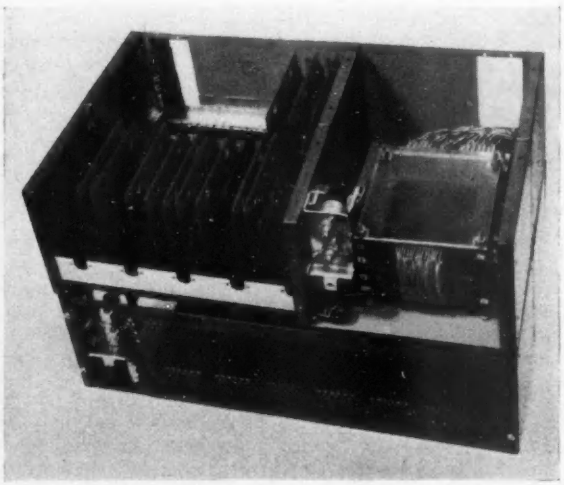


Fig. 1. (a) (above) The 'ODD Y' quarter of the main store

(b) (below) View of the main storage unit



Organization of the Computer

The basic mathematical elements of the computer are a set of fifty integrators, each of which is represented by a pair of binary numbers, Y_j and R_j ($j = 1, 2, \ldots 50$). These numbers, of sixteen binary digits, are stored on a 50 × 32 magnetic core matrix, from which they are read together in parallel; i.e. the Y and R numbers corresponding to one integrator are treated within the store as a single 'word' of 32 bits. In one complete 'machine cycle', all fifty words are read in the fixed sequence 1, 2, 3, ... 50, 1, ... Each machine cycle occupies 2msec, so that the read-out times of successive words are spaced at 2msec/50 = 40μsec intervals. This period of 40μsec, known as an integrator period and defined, for word j, by the symbol I_j, is occupied in transferring the number pair Y_j and R_j through an arithmetic unit. The arithmetic unit employs serial logic,

* *Royal Aircraft Establishment, Farnborough*

necessitating a pair of shift registers to convert the parallel outputs of the store to serial form. In the arithmetic unit, the numbers are operated upon according to a fixed programme, producing two new numbers Y_j^* and R_j^* which are returned to the locations previously occupied by Y_j, R_j in the main store, to be read as a new Y_j and R_j during the succeeding machine cycle. Y_j^* and R_j^* are generated in serial form with a single digit delay between the corresponding digits of Y and Y^* and have to be staticized before they can be written into the store; the serializing shift registers are used for this, and the word transferred in parallel to a set of 32 buffer stores, at the end of I_j. The situation at the end of I_j is thus:

Location j in the store is clear; the contents of location $j + 1$ are about to be read into the shift registers; the new Y_j^* and R_j^* are in the buffer store, awaiting the process of writing into location j.

The write operation for Y_j^*, R_j^* takes place about halfway through I_{j+1}. Since this involves only the buffer and main stores there is no disturbance of the numbers Y_{j+1}, R_{j+1} then circulating through the shift registers. It will be observed from the above, however, that the read/write

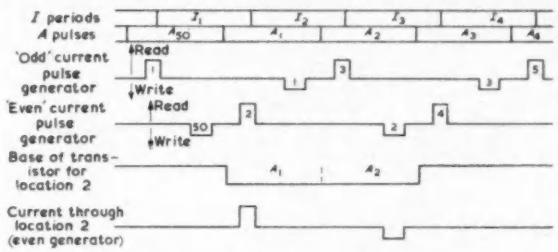


Fig. 2. Detailed timing of the store

sequences of adjacent locations are interleaved, in the order: ....read 2, write 1, read 3, write 2, read 4.... (Fig. 2).

This interleaving is in some respects inconvenient, and is avoided by splitting the store into two halves comprising the odd and even locations respectively.

The sequences in the two halves then become:

ODD..... write 1 read 3 write 3..

EVEN.... read 2 write 2 read 4.....

and in each half a read operation is followed by a write in the same location.

The locations are read by passing current pulses through the core matrix. The same current interrogates both Y and R numbers simultaneously. Similarly, the read amplifiers and buffer stores associated with the separate digits are common to the odd and even halves of the store. Fig. 1(a) depicts the ODD Y quarter of the store, the remaining sections (even Y, even and odd R) being similar.

The Core Matrix and Address Selection System

THE MATRIX

The matrix consists of a 50 word × 32 digit array of ferrite cores with two X or 'word' and two Y or 'digit' wires threading each column and row. The cores are 0·08in diameter and are made of Plessey S3 material, requiring a switching current of the order of 350mA for full read. As this is a high current to be passed by a single transistor the two X wires are joined in a loop so that the current passes twice through each column, requiring a read current of about 175mA in the wire. The Plessey Co. Ltd made the core planes to the authors' requirements.

A word is read in parallel by passing this current through a selected column of the store, the e.m.f. induced by switching each core to the '0' state being detected by a read amplifier on one of the wires threading its row.

Information is written into the store in parallel, one word at a time by:

(1) Passing a word write current of 85mA through the column in the opposite direction to the read current.

(2) Passing a current of 175mA through those rows in which a 'one' is to be written in the selected word.

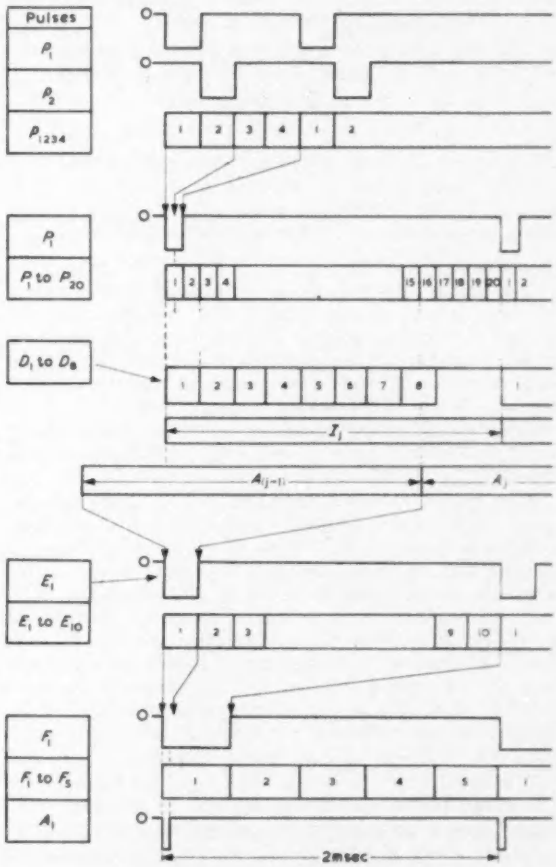


Fig. 3. Computer control pulses

Thus a core in the selected word in which a 'one' is to be written will see a total current of 2 × 85 + 175mA (remembering that the X wire threads the column twice) i.e. approx. 350mA, and will be switched to the '1' state.

Other cores of the same word will experience a current of 2 × 85mA where a '0' is to be recorded and will not switch because the field due to this current is less than the coercive field of the core; they will therefore remain in the '0' state to which they have been switched by the previous read pulse.

Other cores on rows where a one is being written in the selected word will experience a current of 175mA, again insufficient to cause their switching, or disturb their '1' or '0' states appreciably. Finally, cores representing digits of

unselected words and where a '0' is recorded in the selected word will be quite undisturbed.

The word read and write pulses, of controlled amplitude, are generated by current switches common to all locations of the store. The word wires, each in series with its own symmetrical transistor switch, are connected in parallel across the output of these common generators.

Even and Odd Store Locations

In order to use the store in the following sequence:

write 1 read 3 write 3

....read 2 write 2 read 4 ....

in the two halves of the store, the word pulse generators are duplicated and arranged to give an interleaved pattern of read/write pulses as indicated in Fig. 2.

It is now possible to apply a signal turning on transistor VT_2 say, over the period covered by the word pulses:

write 1 read 3

read 2 write 2

VT_2 is thereby caused to conduct the read 2 and write 2 currents through location 2 of the store, while being unaffected by the intermediate pulses write 1, read 3, because these are applied only to the odd half of the store.

The Control Pulses

The timing of operations in a computer is ordained by a set of control pulses, derived from a basic clock and having waveforms repeating at various sub-multiples of the clock frequency[2]. These waveforms are named, depicted, and related in Fig. 3. At each division of frequency, (represented by a gap in the column headed 'Pulses') comparable waveforms are generated at the several output channels, being displaced in phase so that any period of time can be defined by a combination of them.

Most closely related to the I periods are the 50 A pulses, which have a length of 40μsec, period of 2msec and amplitude of nominally -10V. They do not, however, coincide in time with the correspondingly numbered I periods, but are displaced as indicated in Fig. 3. The reason for this is that the word Y_j, R_j is extracted from the store at the beginning of I_j. Now there is an inherent delay both in the appearance of the output signal from a switched core and in the setting up of the symmetrical transistor switches; this delay is accommodated by commencing the setting up and switching processes at the beginning of A_{j-1}, which is arranged to appear before I_j.

The word Y_j,R_j is written back into the store during the period I_{j+1}, in fact before the end of A_j. Location j in the store must therefore be selected during $A_{j-1} + A_j$.

The A pulses are obtained by dividing the frequency of a digit, or P, pulse by fifty. This operation is performed in two stages in a pair of ring counters, the first a divide-by-ten stage followed by a divide-by-five. The 10 outputs of the first counter are labelled $E_1, E_2, \ldots E_{10}$, and provide pulses of the form indicated in Fig. 1. Similarly, the five outputs of the second counter are $F_1, F_2, \ldots F_5$. The signals on these fifteen channels are sufficient to define any word (strictly, any A period) throughout a machine cycle. Any A pulse is generated by the logical combination of one E with one F pulse, thus:

$$A_j = E_m \,.\, F_n$$

where $j = m + 10\,(n - 1) = 1, 2, \ldots 50$.

P pulses occur in the identification of the digits of the words in their serial form and are depicted at the top of Fig. 3. Every I period is divided into twenty P periods, $P_1, P_2, \ldots P_{20}$ defined by pulses from the 20 outputs of a P pulse generator. Inspection of Fig. 3 will reveal that each A pulse spans the sequence of 20 P pulses $P_{16}, P_{17}, \ldots P_{20}, P_1, \ldots P_{15}$. Any digit period throughout a machine cycle may be specified by a logical combination of a P pulse with either an A pulse, I period or pair of E and F pulses. Each P pulse is divided into four phases represented by four p pulses $p_1 \ldots p_4$, each p pulse is of 0·5μsec in duration and is the shortest period of time of significance in the computer.

It has been shown that the signal necessary to complete the circuit through location j covering the 'read j' and 'write j' pulses is $A_{j-1} + A_j$.

This combination is obtained directly at the base of the j^{th} symmetrical transistor by means of a resistor-diode AND gate, (Fig. 4) where a combination of E pulses is applied to a resistor, and an F pulse to the diode, thus:

$$A_{j-1} + A_j = (E_{m-1} + E_m) \,.\, F_n$$

unless $m = 1$ when:

$$A_{j-1} + A_j = E_{10} \,.\, F_{n-1} + E_1 \,.\, F_n$$

The second case requires two resistor-diode AND gates and a diode OR gate, but only occurs in five locations (1, 11, ...41). The principle of the gate is that a current is only drawn from the base when both the resistor and

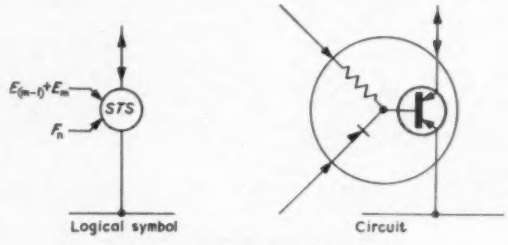


Fig. 4. The symmetrical transistor switch

diode inputs are held negative. The base current required is of the order 20mA. The pairs of E pulses, $E_{m-1} + E_m$ are combined in diode OR gates and buffered by emitter-followers. Further outputs from the divide-by-10 stage are the signals E odd and E even, logically defined as:

$$E_{odd} = E_1 + E_3 + \ldots\ldots + E_9$$

$$E_{even} = E_2 + E_4 + \ldots\ldots + E_{10}$$

These are used to control the operation of the pair of interleaved word pulse generators, as shown in Fig. 1. The read pulse for the odd half of the store occurs only during even E periods (= even A pulses) and the write pulse during odd E periods. This situation is inverted for the even half of the store. The actual timings of the beginnings and ends of the pulses are determined by certain of the P pulses, gated by the E_{even} and E_{odd} pulses as indicated in Fig. 1. The P pulses used to turn on and off the read generators are P_{19} and P_2 respectively; for the write generators P_9 and P_{13} perform these functions.

The Symmetrical Transistor Switch

A symmetrical transistor is a device which has similar characteristics when the conventional collector and emitter connexions are reversed. Its virtue as a switch for driving cores is that it can be made, by signals applied to the base, to conduct or inhibit currents between emitter and collector in either direction (Fig. 4). If the base is taken to a relatively high negative potential through a resistor, then a more or less defined base current will flow and the path between emitter and collector becomes a short-circuit, one

or both of the base-emitter or base-collector diodes being forward biased. Conversely, if the base is taken to a relatively positive potential, so that both the emitter and collector diodes are reverse biased, then the transistor ceases to conduct. Clearly by applying a negative signal to one base, and positive signals to all others of a collection of such transistors in parallel, a current pulse applied to all will be conducted by the one selected transistor. In this way a current pulse on the bus bars of the store is caused to flow through one selected column of cores.

The terms relatively positive and negative used above imply that the collector and emitter excursions must be limited to lie between the positive and negative potentials applied to the base. This is assured by limiting the open-circuit output potential swing of the word current switches to these levels.

The basic store word circuit is illustrated in Fig. 5. The loads L_1 and L_2 represent columns of cores in the store, while the transistors drawn with two emitter symbols are the symmetrical switches. The waveforms at the marked points A, B, C etc. of the circuit are given in Fig. 6, for a

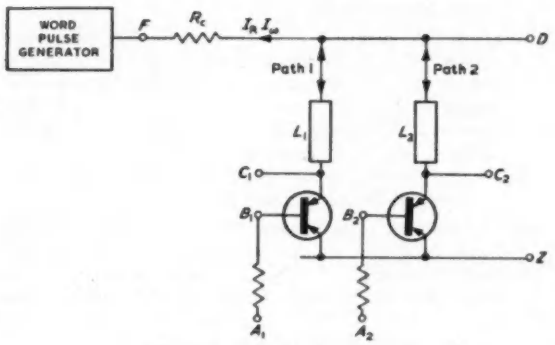


Fig. 5. Two columns of the core store

cycle in which read and write pulses are applied first to load L_1, then L_2, and finally to an inactive store (all paths open-circuit). The potential V_F at F, Fig. 6(b) varies unsymmetrically about that of the common line E, V_Z, so that the read and write currents, which are approximately $(V_F - V_Z)/R_C$ where R_C is the controlling resistor (Fig. 5) have the required values $I_R = 175\text{mA}$, $I_W = -85\text{mA}$. The actual current is $(V_F - V_D)/R_C$, where V_D differs from V_Z by the drop in the transistor, more or less constant and restricted to be $< 0{\cdot}2\text{V}$ by selection of components, together with the drop in the load. The latter varies with the number of cores being switched, having a maximum value of about $32 \times 25\text{mV} = 0{\cdot}8\text{V}$ on the read, and $32 \times 18\text{mV} = 0{\cdot}56\text{V}$ on the write pulse. These figures correspond to a tolerable variation of about ± 5 per cent in the amplitudes of the read/write current pulses, depending on the number of 'ones' recorded in the word.

It will be seen in Fig. 6(a) that the base of a selected transistor reaches a potential slightly negative with respect to V_Z, while that of an unselected base is held at earth potential. As long as one path is selected, the potentials at D and at the unselected points C do not move far from that of Z (Fig. 1(c)), which is fixed by connexion to a stabilized supply. If no path is selected, all these points (C_1, C_2 and D) follow the changes of V_F. Naturally, if two or more transistors were selected simultaneously, the current pulse would be divided between them.

In the normal running of the store, one transistor is selected for each read/write pulse, in which case Fig. 6(b) shows that the potential difference across any transistor never exceeds the combined drop in a transistor and its load, approximately 1V in the worst case.

It should be noted that the rise-time of the current pulse (Fig. 6(a)) is determined by the waveform at F, provided the transistor has been 'turned on' by a base current before V_F begins to rise. The dips in the tops of the current pulses are typical of the switching back-e.m.f.s of a set of cores.

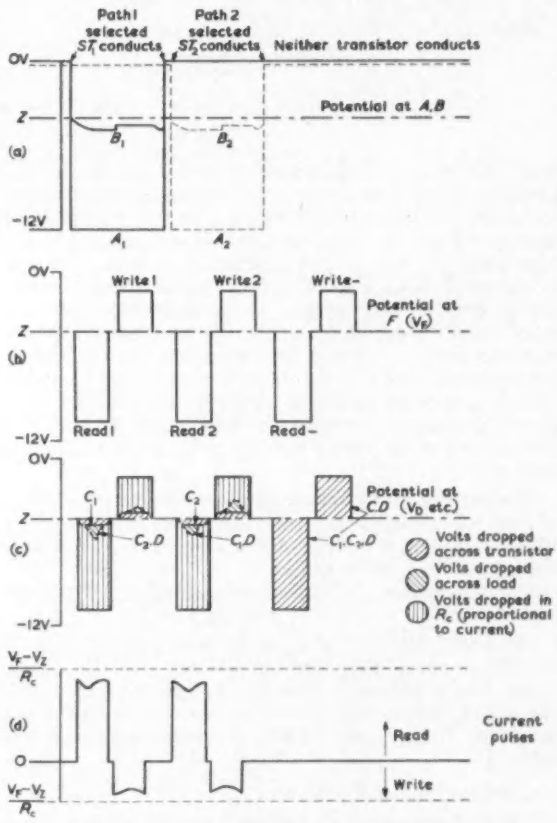


Fig. 6. Waveforms in core store word selection circuits

The switching time of the cores used in the store is about $4{\cdot}5\mu$sec at twice the coercive field and adequate switching is obtained by using 6μsec current pulses.

THE READ AMPLIFIERS (Fig. 7)

The output signal induced on a Y wire due to switching fully a core which it threads is a pulse of approximately 25mV peak amplitude and 2μsec long.

At this level, the signal is too small to switch a transistor so a transformer of ratio 8:150 is used to match it to the impedance of a base. It is then sufficient to saturate a single transistor read-amplifier stage. Such a simple amplifier is possible because with the method of pulsing the store with a full current on a single column, it is not necessary to discriminate against the signals due to partly disturbed cores holding '1's. The only discrimination is against the coupling signal due to a core holding a '0' and this is achieved by gating.

There are two gating circuits common to the read ampli-

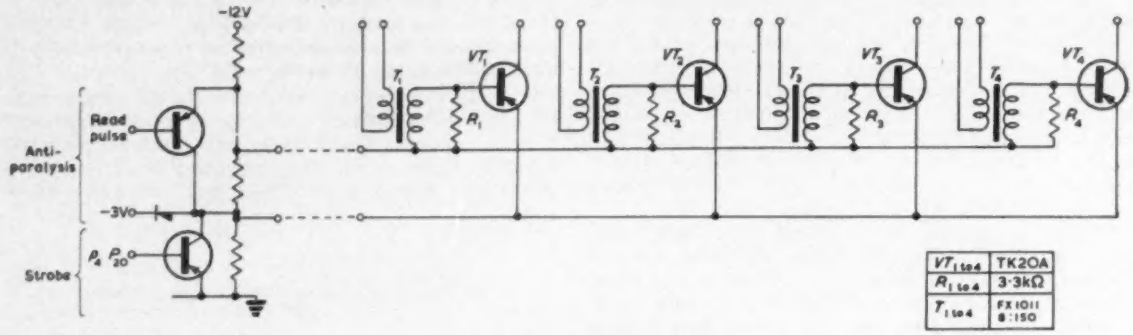


Fig. 7. Read amplifier and gate

fiers. The function of the first is to prevent paralysis of the amplifier. When a one is being written into a core, a current of about 175mA is passed through one of the Y wires threading a row of cores, the other being connected to the read amplifier. The mutual inductance of these wires due to the cores causes a spurious 'one' signal, many times as big as a true 'one' output, to be applied to the read amplifier at the end of the write pulse. This would saturate the amplifier and prevent its correct operation for some microseconds, well into the 'read' period in fact. To avoid this, the secondary circuits of all the transformers are completed through a common transistor which is left in a cut-off state except during the read pulse when it is turned hard on.

The purpose of the second gate, common to the outputs of the read amplifiers, is to define the time at which information read from the cores is transferred to the shift registers. This is chosen to be at the time of peak 'one' output, giving best discrimination against the '0' output signals.

The input signal required at the shift register stages is a positive going pulse from -9V to -3V to record a one. The waveform is illustrated in Fig. 8 together with the gating signals; this shows the case where digit Y_1 of integrator 1 is a 'one' and Y_1 of integrators 2 and 3 is zero.

The Shift Registers (Fig. 9)

The shift registers have been included in this description because they constitute a part of the storage loop if the whole is considered as a device with serial input and output.

Each shift register (one for Y, the other for R) is constructed of sixteen shift stages, which are bistable elements with transfer gates. These are in fact standard circuits developed by Rank Cintel, for use as general purpose binary counters etc., but adapted to a special size of board with twelve printed circuit connexions. The voltage levels at which the shift stages work, namely -6V for a '0' and $-10{\cdot}4$V for a 'one' output, differ from those used both in the buffer store and the arithmetic unit. This necessitates the use of coupling elements in the serial parts of the loop and non-standard gate elements and signals for the parallel transfers. Shift pulses are generated in driver stages and are made available to the shift stages on a common bus.

The sequence of operations concerning the shift registers is as follows:

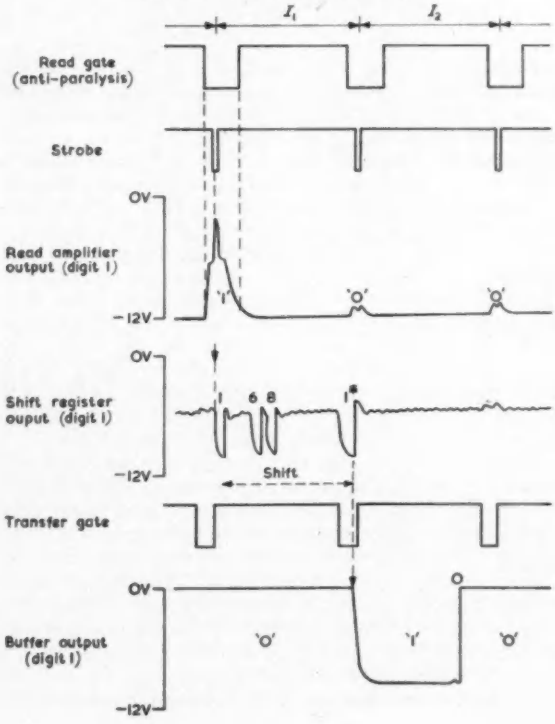
(1) On $p_4 . P_{20}$ of I_{1-1}, the digits Y_{1-16}, R_{1-16} of word j are gated out of the read amplifiers into the shift register stages in parallel. The first digits, Y_1 and R_1 are then available from stage 1, the serial output point of each register.

(2) On $p_4 . P_1$ the first shift pulse is applied causing all digits to move down one place, and leaving Y_2, R_2 in the output stages.

(3) On $p_4 . P_2$, $p_4 . P_3$, ... $p_4 . P_{17}$ further shift pulses are applied. On $p_4 . P_2$ the first new digits of Y and R namely Y_1*, R_1* are gated into the serial input points, stages 16. It will be noted that there is a single digit gap in the returned information due to the logical delay in the arithmetic unit. The last shift pulse is $p_4 . P_{17}$, after which the stages 1-16 contain the corresponding digits of Y* and R*.

(4) The transfer gates between the shift registers and the buffer store are opened over the period P_{18}, and the transfer completed before the clear pulse on $P_{20} . p_1$ which sets all the shift stages to the 0 state. The

Fig. 8. Waveforms in the store loop



signal at F from the shift stage is buffered by an emitter follower, and combined with the transfer signal at H in a resistor AND gate. A Zener diode is used as a voltage shifting and discriminating element, to couple in the non-standard signal.

Fig. 8 shows the waveform at stage one of the shift register, for the situation where digits Y_1, Y_6, Y_8 and Y_1* of integrator 1 are 'one' and all other digits (including integrators 2 and 3) are zero. It also shows how the new digit Y_1* is transferred into the buffer store 1, when the transfer gate is opened.

plementary inputs (K and E) and outputs (J) in the external access function of the buffer store and for clearing the words after they have been transferred to the core store.

To transfer information from the bistables to the cores, it is necessary to close some sort of current switch producing a pulse of the requisite amplitude, 175mA, in synchronism with the word write pulse. A transistor VT_3 is used as the current switch driven via a transformer from the false output of the bistable. One side of the transformer primary is taken to the collector and the other via diode $MR_{3,8}$ to a bus, normally held at earth poten-

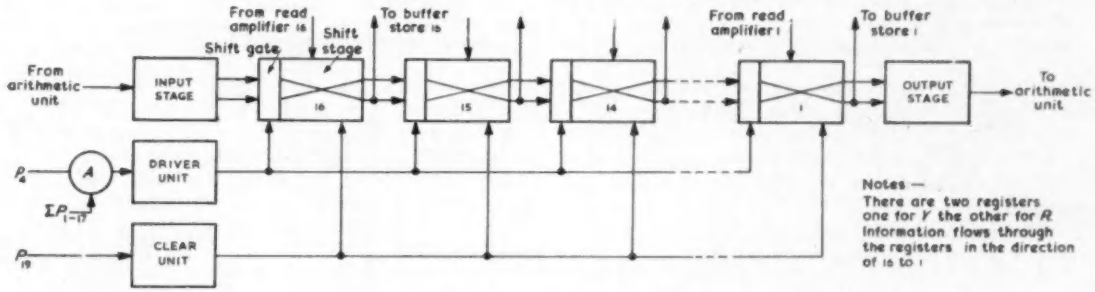
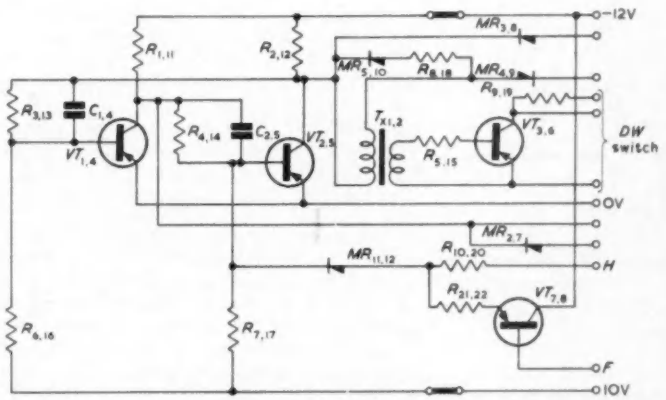


Fig. 9. The serializing shift register



$VT_{1,2,4,5}$	TK20A
$VT_{3,6}$	OC72
$VT_{7,8}$	OC45
$T_{X1,2}$	(20 :1 FX1011
$MR_{1\text{ to }10}$	OA71 (CV448)
$MR_{11,12}$	SX62
$R_{1,11}$	2·2kΩ
$R_{2,12}$	2·2kΩ
$R_{3,13}$	15kΩ
$R_{4,14}$	10kΩ
$R_{5,15}$	33Ω
$R_{6,16}$	33kΩ
$R_{7,17}$	33kΩ
$R_{8,18}$	470Ω
$R_{9,19}$	15Ω
$R_{10,20}$	2·7kΩ
$R_{21,22}$	3·3kΩ
$C_{1,4}$	120pF
$C_{2,5}$	270pF

Fig. 10. FF2/DW buffer store

The Buffer Store

STORAGE

The buffer store holds the word Y_j*, R_j* from the time of its transfer from the shift registers at the end of I_j, until it is written into the main store during I_{j+1}. It also serves as the input and output access point for information in parallel form. It consists of a set of 32 bistables (Fig. 10) mounted two per board together with components of the digit writing circuits.

The two collectors, corresponding to the true and false values of the digit stored, are also brought out, the true signal directly at J, and through a diode at K and the false signal via a diode at E. These points are used as sup-

tial, so that regardless of the state of the collector (earth if a 1 digit is stored, −10V if a zero is stored, reverse biasing the diode) there is no potential across the transformer primary.

During the write pulse, the bus is taken to −12V, most of which potential is dropped across the transformer primary where a one is stored. This causes a negative pulse to be applied to the base of the current switch transistor VT_3 turning it 'on'. Where a '0' is stored, the voltage applied to the transformer primary is of the order of 2V through the impedance of the resistor network R_2, and $R_{3,13}$. The output from the secondary in this case is insufficient to turn on the current switch. The resistor-diode

by-pass MR_5 and R_9 is necessary to reduce the voltage spike at the primary when the driving pulse from the bus is turned off.

The timing of these operations is as follows:

(1) The previous contents of the buffer stores, Y_{j-1}*, R_{j-1}* are cleared by earthing the bus connected to (K) on P_{15} of I_j. Incidentally, the positive going edge from the true output is used to transfer the numbers Y*, R* into a set of indicating flip-flops. Each of the indicating flip-flops has a light bulb in one of its collector leads, and the contents of any integrator may be selected for display.

(2) On P_{18} the gate points (H) are taken to -6V being otherwise held at earth potential. This allows a '1' signal at F to turn on the right hand transistor VT_2

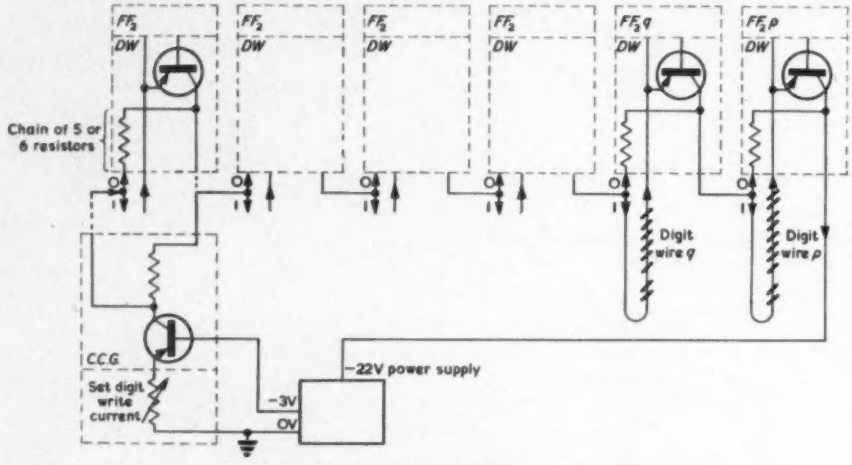


Fig. 11. Digit write circuits

causing the bistable to change to the '1' state. The buffers now contain Y_j* and R_j*.

(3) On P_8 of I_{j+1} the bus (connected via MR_3 on the circuit diagram) is driven to -12V, turning on the current switches (VT_3) wherever a '1' is recorded. The bus is returned to earth on P_{12}.

The Digit Write Circuit

A major difficulty with parallel word inputs to a core store is the large current pulse required to write the maximum number of 1's. Thus, to write Y and R words consisting entirely of ones, a current pulse of 32×175mA $=$ 5.6A is necessary. This would require a specially designed power supply, careful siting of leads etc. To avoid this a constant current system* was devised which is less efficient than a parallel system, with regard to power wastage, but considerably easier to design and develop.

It has been shown that each of the buffer stores controls a current switch transistor (VT_3) through a transformer coupling. The emitter-collector circuit of this transistor is in series with a Y wire of the store, the combination being connected across a resistor. Groups of five or six of these resistors are connected in chains and driven by a constant current generator (Fig. 11). In all, there are six of these chains to drive the whole store, four of them controlling five digits each and two, six digits.

The principle of operation is as follows. Each chain carries a current of approximately 190mA, which flows through the resistors. When the buffer store transformers are pulsed, certain of the current switch transistors are turned 'on', i.e. the emitter-collector path becomes effectively a short-circuit. The current at these sections divides between the resistor and the transistor with its load of cores. Since only one of each load of fifty cores is switched, the impedance and back e.m.f. of the path through the cores is low and most of the constant current of 190mA flows through it. In fact the relative impedances (15Ω and 1Ω) are such that 175mA, the desired switching current, flows through the store. It will be seen that the requirement to accommodate an occasional current pulse of 5·6A has been replaced by one of tolerating voltage pulses. For, when all six digits of a chain are 'one', the voltage across the chain changes from

$$-6 \times 15 \times 190\text{mW} = 17{\cdot}1\text{V}$$

to

$$6 \times 15 \times 15 = 1{\cdot}3\text{V}$$

Each chain is driven by the -22V supply of the computer, so that the voltage across the constant current generator must occasionally rise from the standing value of

$$-22 + 17{\cdot}1 = -4{\cdot}9\text{V}$$

to

$$-22 + 1{\cdot}3 = -20{\cdot}7\text{V}$$

The constant current generator is a simple device wherein a transistor is used to compare the voltage drop in a fixed resistor carrying the current with a stabilized supply of -3V. The maximum mean dissipation in the transistor is one watt, which is removed by a 4in square heat sink.

Since the cores are of a relatively slow switching ferrite, and there is no need to detect an output during the write pulse, the form of the switching pulse is only limited by a minimum length and amplitude. To suppress switching transients, a rectangular pulse shape is avoided by using relatively slow transistors in the (VT_3) positions. This causes a slight delay in the appearance of the digit pulse and for this reason the word pulse is initiated and terminated by a later pair of P pulses (P_9 and P_{13}) than the digit pulse (P_8 and P_{12}).

Constructional Details

A general view of the core store, read and write circuits and the buffer store is given in Fig. 1(b). The shift registers together with the indicator flip-flops occupy a separate tray. The two trays containing the store and its most intimate circuits are permanently connected by two looms of wire which permit the trays to be opened wide enough for easy maintenance. All connexions with the computer, however, are made automatically when the trays are plugged into the cabinet.

* *This constant current method of driving a core store is the subject of Patent Application 17 975/60 in the name of M. F. Partridge.*

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A Simple Circuit for the Protection of the Stabilized Transistor Power Supplies †

By D. T. Jovanovic* and R. P. Ilic*

A simple circuit is described for the protection of series stabilized transistor power supplies against sudden overloads and short-circuits. The circuit, when operated, ensures that the dissipation of the series transistor will be within the permissible value, allowing the power supply to deliver a certain load current even under short-circuit conditions. In addition, the circuit enables automatic resetting of the stabilized power supply after the cause of the overloading has been removed. As an illustrative example the behaviour of a practically realized stabilized transistor power supply for 6·3V 2·5A using the described overload protection is given.

(Voir page 547 pour le résumé en français: Zusammenfassung in deutscher Sprache auf Seite 554)

IF the series transistor in a stabilized power supply is operated near its maximum permissible ratings, it may be destroyed by a sudden overload or short-circuit. Commercially available thermal fuses and fast relays are inadequate for protection because of their relatively slow action. The problem of a more rapid protection system has been dealt with by several authors. The protection circuit given by Kemhadjian and Newell[1] consists of one bistable circuit arranged in such a manner that when the load current exceeds a permissible value, it is triggered into its other stable state cutting off the series transistor by means of a small positive voltage applied to its base. After the fault has been removed the circuit must be reset manually to its previous stable state. Thus, only two states of the overall power supply are possible: the state of normal operation (the output voltage stabilized, the load current variable from zero to maximum permissible value) and the state of the definitely cut-off condition for the series transistor (the load current is near zero). However, the need of resetting the instrument after every overload may be impractical in certain cases such as capacitive loading or heating thermionic valves. Thus, it is necessary to develop a protection circuit which, when operated, will not cut off the series transistor completely, but will only limit its dissipation, allowing the power supply to deliver a certain load current under reduced output voltage (non-stabilized now). The circuit described below satisfies the required conditions.

Basic Circuit

The basic protection circuit incorporated in the stabilized power supply is shown in Fig. 1. The transistors VT_1 and VT_2, the resistors R_2 and R_3 as well as the reference voltage V_r represent the conventional circuit of a series stabilized power supply. The protection circuit (inside the dashed line in Fig. 1) consists of the transistor VT_3, the voltage divider chain RV_1R_5 and the resistors R_4 and R_6. The collector of the transistor VT_3 is connected to the base of the series transistor VT_1. In normal operation the voltage proportional to the load current developed across the resistor R_4 is lower than that across the potentiometer RV_1 in the voltage divider chain. Therefore, the transistor VT_3 is in the cut-off condition without affecting the operation of the stabilized power supply. When the load current exceeds a predetermined value, the voltage drop across the resistor R_4 is larger than that across the potentiometer RV_1 and the transistor VT_3 begins to conduct. The base current of the series transistor VT_1 decreases, at the same time causing the load current to decrease. Now the diminished load current results in a lower voltage across the resistor R_4. It might be expected at a first glance that the transistor VT_3 would become cut-off again and that the whole circuit would operate as a current limiter. However, this is not the case, because, when the action begins the transistor

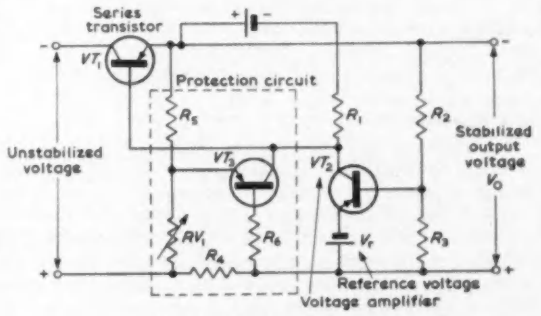

Fig. 1. Basic protection circuit

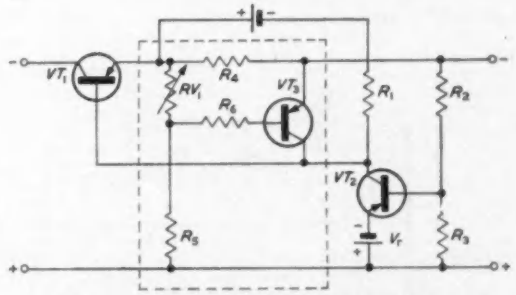

Fig. 2. Modification of basic protection circuit

VT_3 continues to conduct due to the decreased output voltage V_0 across which the voltage divider chain RV_1R_5 is connected. The decreased output voltage causes the voltage drop across the resistor R_3 in the voltage divider chain R_2R_3 to become lower than the reference voltage V_r and the voltage amplifier transistor VT_2 is thereby cut off. Therefore, when the transistor VT_3 is conducting, the output of the power supply ceases to be stabilized, but a certain load current is still ensured even in the case of a short-circuit. The ideal case would be for the load current to decrease at the same rate as the voltage drop V_1 across the series transistor VT_1 increases. In this case the dissipation of the series transistor with the load resistance in the overload region is maintained constant whatever the value of the load resistance. The characteristics shown in Fig. 3

† *Yugoslav patent application No. 2948/60.*

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refer to the practically realized transistor power supply of Fig. 4 which is protected against overload by means of the previously described protection circuit. As can be seen in Fig. 3, the dissipation (W) of the series transistor in the overload region is not constant, first increasing for certain values of the load resistance and then again decreasing. This behaviour of the protection circuit is satisfactory enough for practical purposes.

Fig. 2 shows a modification of the basic protection circuit. Here the resistance R_4 is placed in the negative instead of in the positive lead of the power supply. The principle of operation is the same as for the basic circuit shown in Fig. 1. This case is more convenient for stabilized power supplies of higher output voltage, but requires the transistor VT_3 to be of low knee type.

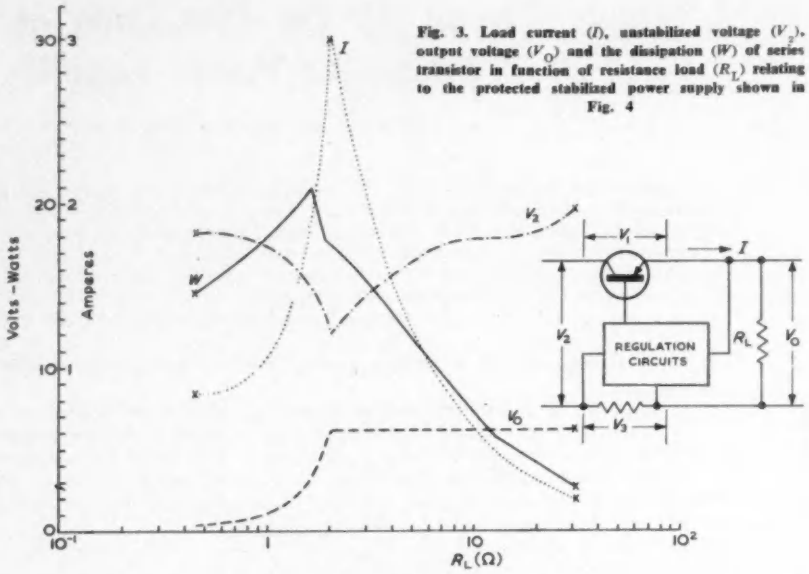


Fig. 3. Load current (I), unstabilized voltage (V_2), output voltage (V_O) and the dissipation (W) of series transistor in function of resistance load (R_L) relating to the protected stabilized power supply shown in Fig. 4

Practical Example

The stabilized transistor power supply, the details of which are shown in Fig. 4, was designed primarily for the heating of thermionic valves. It is capable of delivering 2·5A at 6·3V. The protection circuit consists of transistor VT_3 (Philips OC76), the voltage divider chain RV_1R_5 and the resistors R_4 and R_6. Potentiometer RV_1 serves for adjusting the value of the load current when the protection circuit is operating. For the case under consideration this current has been adjusted to 3A as can be seen in Fig. 3. The dissipation of the series transistors (three Philips OC16 in parallel) is within the permissible limits for every value of the load resistance (including zero) (providing the cooling fan of the series transistor is properly designed). The measured characteristics of the stabilized power supply with and without the protection circuit in normal operation are the same:

Internal resistance $R_i = 20\text{m}\Omega$,

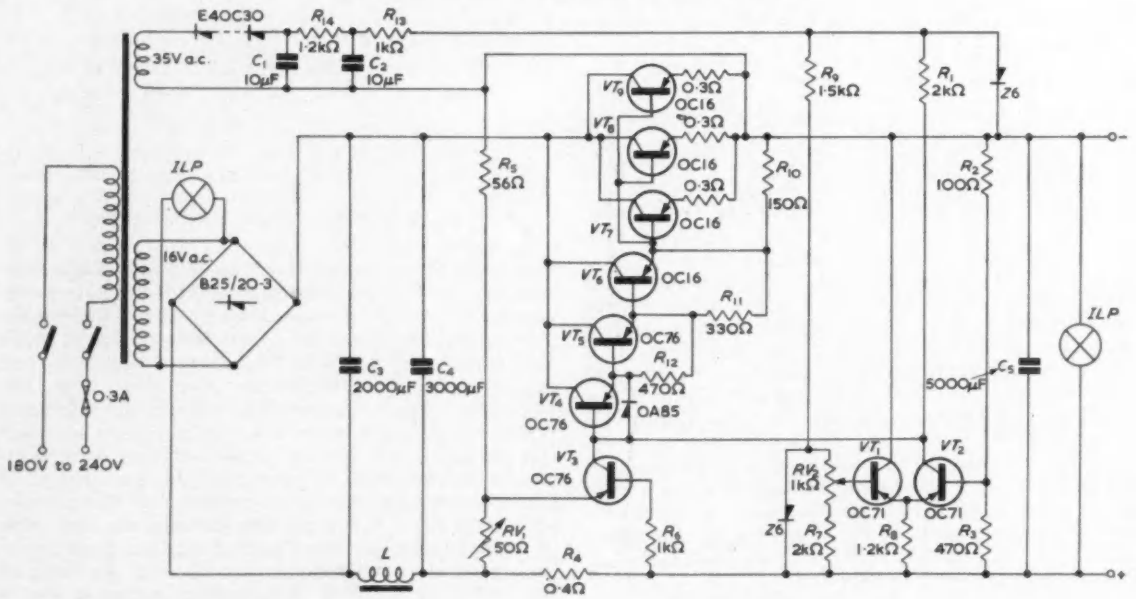
Regulation = 0·3 per cent (mains 180V to 250V),

Temperature stability = 4mV/°C.

Conclusion

The protection of the series transistor of the stabilized transistor power supply against overload can be realized by using only one transistor and four resistors. The reli-

Fig. 4. Complete protected stabilized power supply 6·3V/2·5A



ability of such a simple protection circuit has proved to be satisfactory. This circuit, when operated, does not switch off the series transistor completely, but allows the power supply to deliver a certain load current even in the case of a short-circuited output. The dissipation of the series transistor is limited to the permissible value. In addition, the circuit allows the automatic resetting of the stabilized power supply after the cause of the overloading has been removed. These advantages of the circuit make it widely applicable in the design of any series stabilized transistor power supply, particularly when the power supply is required to deliver a certain load current even under conditions of overload.

Acknowledgment

The authors wish to thank M. Kovacevic for his assistance in the construction of the instrument.

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A Computer Centre for a Bank

The opening of Barclays Bank No. 1 Computer Centre marks a stage in the development of automation in banking. It is believed that its combination of transistorized computer and telecommunications constitutes the most advanced bank book-keeping system in the world.

When the first computer is fully operative it will handle the the book-keeping of 40 000 accounts at twelve of the Bank's West End branches.

The premises housing the Computer Centre have been designed specifically for their purpose and in addition to the operating area which has been designed to house a second computer specialized accommodation is provided for all those who will be working in the centre. The ancillary accommodation includes a service department, a lecture room for the training of staff and a typical branch installation for training operators for the branch end of the system.

The computer employed in the system is an EMIDEC 1100, manufactured by E.M.I. Electronics Ltd. This is a medium-sized, fully transistorized computer, comprising a magnetic core immediate access store of 1 024 words, a 16 384 word magnetic drum, a parallel arithmetic unit, and a control unit in which the detailed operations to be performed for each instruction are derived from the lacing of a matrix of magnetic cores. Supporting the main computer are magnetic tape units on which the main record for all accounts is stored. Photo-electric paper-tape readers, and high-speed paper-tape punches, both operating at 300 characters a second, provide input and output to the computer.

All branches served are connected to the Centre by teleprinter lines, over which information regarding customers' entries is passed. By these means it is possible to avoid the movement of vouchers away from the branch. At each branch one or more accounting machines with paper-tape punching attachments are installed. On these machines a journal is prepared analysing and proving all entries passing through the branch. As entries on customers' accounts are entered in this journal details are punched into the paper-tape as a by-product of this audit operation. Accounts are identified by account numbers, these numbers being printed on cheques and paying-in books as issued to customers.

At intervals the punched paper-tape is transmitted over the teleprinter lines to the Centre, where a duplicate tape is automatically produced. Before these tapes are passed to the computer they are checked electronically to detect punching or transmission errors. The computer would in fact find these errors itself, but by disposing of these errors in advance the introduction of this input checking equipment allows the computer to operate at its greatest efficiency. The input checking equipment was designed by a member of the Bank's staff, as there was no equipment on the market, or under development, which would perform this checking function.

The tape-checking equipment is designed to locate certain types of error which occur in the punched paper tapes used as input to a computing system.

In this instance the computer is supplied with data obtained, at remote points, as the by-product of normal book-keeping operations performed by conventional accounting machines with paper tape attachments. Conditions exist which preclude the possibility of 'double punching and verifying' to ensure accuracy although there is an arithmetic check on the sterling amounts by the accounting machines. Each branch office is linked to the Computer Centre by telegraph lines and all data is passed via auto-transmitters and reperforators operating at ten characters per second.

In order to minimize the amount of computer time lost due to corrupted input information, a study was made of this problem and has resulted in the design of some off-line checking apparatus. This equipment is capable of detecting a very high percentage of the errors which can occur (for various reasons) in the data tapes received at the Computer Centre and thus enables action to correct these tapes to be taken before they are fed to the computer.

The analysis of faults over a test period showed that such errors as occurred tended to fall into one of two classes:

(1) Corruptions of a single 'bit' in a code character—e.g. the loss of one hole on the tape.

(2) Information blocks of incorrect length were sometimes originated by the accounting machine.

Referring to (2) above it is the practice to use a fixed 'field-length' on the tape to represent data entered on the accounting machine keyboard. It is also practice to make the accounting machine punch the sign of numbers and sterling amounts (where required) and the block 'end-marker' symbol quite automatically thus relieving the machine operator of the responsibility of 'keying-in' these characters. Any failure of the automatic sign or block end-marker circuits renders the information meaningless and, in addition, wrongly sequenced operation of the accounting machine may produce blocks of incorrect length.

The checking equipment was designed with these points in mind and the present model has two functions:

(1) To perform an 'odd-parity' check on each character on the tape (a suitable tape code being used).

(2) To compare the length of each block on the tape with a standard, pre-set in the machine.

The punched paper tape is read by a built-in tape reader which operates at fifty characters per second.

The logical circuits of the machine are arranged so that the tape being read is halted, and an 'error' warning lamp is lit, whenever the criteria, outlined in (1) and (2) are not satisfied.

Having discovered an error the operator marks its position on the tape and re-starts the machine. This procedure continues until the tape is completely checked at which time it is removed from the machine, the errors examined and the appropriate action taken. (This usually takes the form of 'blanking out' the faulty blocks on the tape and instructing the originating office to re-punch and re-transmit the information contained in these blocks.)

After checking, tapes are fed into the computer through a high-speed photo-electric tape reader. Magnetic tapes bearing a complete record of all customers' accounts to date are mounted on the magnetic tape read/write machines, and this information is also fed into the computer. The main computer operation is then to combine these two sets of information—the old record and the days entries—and to record on a second magnetic tape an up-to-date account history. During this operation new balances are obtained which are compared with limits, and interest, turnover, and other statistical calculations are made. While this operation is being carried out a punched paper-tape containing the details required by the branch manager for the day-to-day control of his accounts is prepared. This tape is transmitted back to the branch over the same teleprinter lines as were used for bringing the original information from the branch to the computer, and a record is printed out in the branch.

Customers' statements are prepared on a diary or cycle basis, with a copy for retention by the Bank as a ledger. Calls for statements are fed into the computer together with the up-to-date account records. Once more, paper-tape serves as the output, and the teleprinter network is brought into use, and the statements are printed out in the branches ready for dispatch to customers.

The Stability of Reference Tubes Using Mono-crystalline Cathodes

By F. A. Benson*, D.Eng., Ph.D., A.M.I.E.E., F.I.E.S., and B. Rigg*, B.Eng.

The reproducibility and stability of the running voltage of glow-discharge reference tubes having single-crystal molybdenum cathodes are compared with, and shown to be better than, those of similar tubes with poly-crystalline cathodes. The tubes described use crystal slices cut so as to expose the (1, 0, 0) face and are filled with neon +0·3 per cent argon at a pressure of 45mm Hg.

(Voir page 547 pour le résumé en français:
Zusammenfassung in deutscher Sprache auf Seite 554)

A GLOW-DISCHARGE tube for use as a reference element normally uses a cathode made from molybdenum sheet which is cleaned by sputtering the surface in the discharge. A layer of molybdenum is deposited on the glass walls by continuing the cathode sputtering for a time after the cleaning operation. This serves as a shield between the glass walls and the discharge to prevent the discharge liberating gases from the walls. The sputtered molybdenum also acts as a getter.

In 1949 Penning and Moubis[1] successfully determined reliable values of the normal cathode fall for many cathode materials, including molybdenum, in neon. Prior to this, large variations for cathode-fall values were found in the literature and, at present, variations of running voltage are observed between normal reference tubes of the same design made at the same time and also operated under identical conditions.

Ahsmann and van Gelder[2,3] have recently found that the most reliable and stable values of normal cathode fall can be obtained by using single-crystal cathodes. They confined their measurements, however, to tubes with cathodes of germanium, silicon and copper. Some tubes have now been made with single-crystal molybdenum cathodes. The construction of these tubes is described below and the running-voltage stability observed is compared with that of tubes having cathodes of normal crystalline-sheet material.

The orientation of the crystal was found by the standard Laue method, and several slices were cut from the crystal to expose the (1,0,0) face. These slices were ground and electropolished on both sides and again checked for the correct orientation; they were then mounted as shown in Fig. 1 to form cathodes. The cathode (*c*) was not welded to supports in order to prevent damage to the crystal structure, but pressed on to a glass cylinder (*g*) by means of molybdenum-wire straps (*s*). The anode (*a*) is mounted across the base of the glass cylinder, two types of anode being used, one tube being made as shown in Fig. 1(a) and two as in Fig. 1(c). An auxiliary anode (*x*) is used for sputtering the glass envelope from the reverse face of the crystal, this anode can be clearly seen in Fig. 1(b). The tubes were evacuated and filled with a gas mixture of neon + 0·3 per cent argon at a pressure of 45mm Hg.

* *The University of Sheffield*

The tubes were prepared by the well-known sputtering technique, the reverse side of the crystal being sputtered first, using the auxiliary anode, in order that the impurities in the gas could be taken up without removal of material from the cathode surface nearest the main anode. The front surface of the cathode was then sputtered to remove all the surface impurities, this also covers the inside of the glass cylinder with a sputtered layer.

Four tubes of standard cylindrical construction with polycrystalline cathodes made from sheet molybdenum, as shown in Fig. 2 were filled at the same time so that the characteristics could be compared with the single crystal ones.

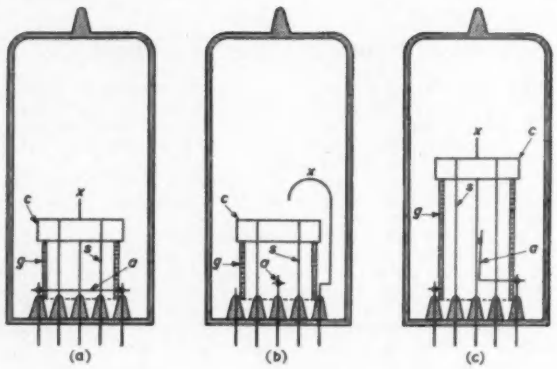

Fig. 1. (above) Mounting of experimental single-crystal molybdenum cathodes

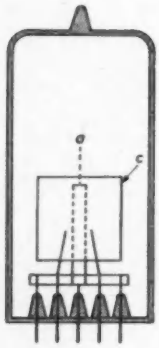

Fig. 2. (left) Tube with standard cylindrical construction and poly-crystalline cathode as used for comparison

Table 1 shows the recorded values of minimum running voltage for the various tubes.

On further sputtering, the voltage of two of the single-crystal tubes rose for no obvious reason and these cathodes are now being remounted. Fig. 3 shows the running voltage variations over a period of 300 hours for the remaining five tubes. It will be seen from these curves and from Table 1 that the running voltage of the single-crystal cathodes is more reproducible than for poly-crystalline cathodes of the same material; also that the

TABLE 1

Running Voltage in Neon + 0·3 per cent Argon at 45mm Pressure

	SINGLE-CRYSTAL (1,0,0) FACE			POLYCRYSTALLINE			
RUNNING VOLTAGE (V)	83·780	83·855	84·000	86·140	85·935	86·450	86·290
MEAN VALUE AND DEVIATION σ (V)	83·88 $\sigma = 0{\cdot}09$			86·20 $\sigma = 0{\cdot}20$			

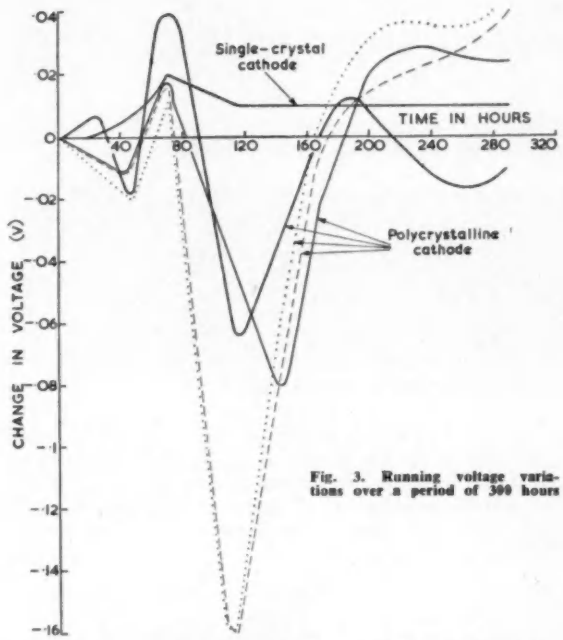

Fig. 3. Running voltage variations over a period of 300 hours

voltage is very constant with time. Table 2 shows the magnitude of these variations.

With the single-crystal cathodes there are no voltage jumps in the running-voltage/current curves such as occur at low values of current with polycrystalline cathodes. (These jumps are about 0·2V in the polycrystalline samples measured.) These spontaneous jumps in voltage may be due to the measured running voltage being an average of the running voltages of the different crystal faces exposed to the glow. If the cathode glow moves to another part of the cathode then the crystal faces covered by the glow, and hence the running voltage, will change.

The cathodes had a polished 'mirror-like' finish when mounted but after sputtering the surfaces contained relatively deep (0·01in) hollows inside which the surfaces were rough. Such surfaces will be examined to find which crystal faces have been exposed during sputtering. Tubes containing cathodes cut along the (1,1,0) and (1,1,1) faces are being produced to compare their characteristics with those obtained for the (1,0,0) face.

TABLE 2

Maximum Change in Running Voltage Over Given Periods of Time

	MAXIMUM CHANGE IN VOLTAGE (Parts in 10^6)		
	1st 100 hours	Next 200 hours	Total 300 hours
Tube with Single Crystal Cathode	+22 − 0	+ 0 − 4	+22 − 0
Tube with Polycrystalline Cathode	+47 −32	+45 −43	+47 −76
Tube with Polycrystalline Cathode	+21 −31	+51 −62	+21 −93
Tube with Polycrystalline Cathode	+21 −132	+182 −51	+47 −186
Tube with Polycrystalline Cathode	+14 −137	+213 −49	+76 −186

Acknowledgments

Acknowledgment is made to Dr. C. M. Haworth and his colleagues of the University of Sheffield Metallurgy Department for help with preparation of the crystal slices, to the English Electric Valve Co. Ltd for helpful advice and the loan of equipment used in making the tubes and to Dr. J. A. Belk of the Armament Research and Development Establishment for supplying a molybdenum crystal.

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Secondary Surveillance Radar at London Airport

A secondary surveillance radar system has been installed at London Airport by Cossor Radar and Electronics Ltd, for experimental purposes and to gain operational experience.

The experimental installation uses engineered equipment for gaining operational experience in the use of secondary radar and for determining the siting and maintenance requirements. The system will also be used to prove the feasibility of automatic transmission of height information from aircraft to ground and experiments in this direction are starting within the next few weeks.

The civil secondary surveillance radar was developed by Cossor as a private venture, and was subsequently adopted as a standard system by ICAO in 1957. The ground equipment has been engineered to a British Government specification in conformity with the ICAO requirements.

Experimental work on the system is also being carried out in the U.S.A. In that country the Federal Aviation Agency has commissioned a number of ground stations for experiment in the use of the system. Those which are operational in this way are of a less advanced design than the London Airport equipment but experimental work is also being carried out on equipment having facilities similar to those of the British equipment. As a part of their operational evaluation, the U.S. authorities are requiring high-flying aircraft, using certain routes over the U.S.A., to carry 'Transponders'.

The Ministry of Aviation announced earlier this year that when the present experimental system becomes operational, high-flying aircraft wishing to operate in certain areas of the United Kingdom airspace will also have to carry transponders and that the minimum height (initially probably of the order of 25 000ft) above which the carriage of transponders would be necessary will subsequently be lowered progressively as and when ground and aircraft equipment programmes permit.

In a secondary surveillance radar system a transmission from the ground equipment 'interrogates' the airborne transponder which then replies with a train of pulses. Sixty-four different pulse combinations are available and these are used as codes to convey information from the aircraft to the ground. The ground equipment decodes the pulse combination and presents the information to the air traffic controller. At the same time the usual p.p.i. presentation provides range and bearing information for the same aircraft. In addition to the air-ground coding arrangement there are means of varying the 'mode' of the interrogation (i.e. the spacing between the pulses which form the interrogation). This has the effect of altering the 'question' which the transponder is asked and thus eliciting a different kind of 'answer'. Thus, an interrogation on one mode may be used to obtain information concerning the identity of the aircraft and an interrogation on another mode may be used to determine the aircraft's altitude.

Transponders have already been supplied by Cossor for use in the jet fleets of B.O.A.C., Air France and Air India International and are on order for other airlines.

The principles and system design problems of secondary radar are dealt with at some length in an article by D. H. R. Archer, part 1 of which appeared in the July issue of *Electronic Engineering* and part 2 of which appears on page 490 of this issue.

The Collector Coupled Complementary Pair

By Spány*

This article describes the collector coupling of a pair of complementary transistors in both the bistable and astable modes of operation. The astable mode makes possible the production of "Phantastron" type waveforms in which the peak-to-peak voltage is almost equal to the supply voltage. The non-regenerative mode makes the production of a variety of waveforms possible.

(Voir page 547 pour le résumé en français; Zusammenfassung in deutscher Sprache auf Seite 554)

VARIOUS methods of connecting complementary pairs of transistors have been described[1,2]. The purpose of this article is to describe the method of collector coupling and to show how it may be used. The basic connexion is shown in Fig. 1, and the different modes of operation are dealt with below.

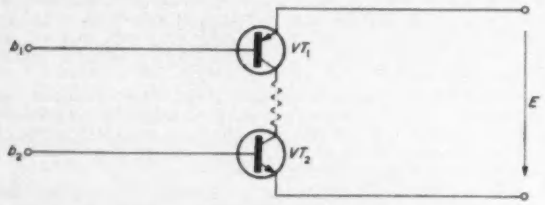

Fig. 1. Collector coupling of the complementary pair

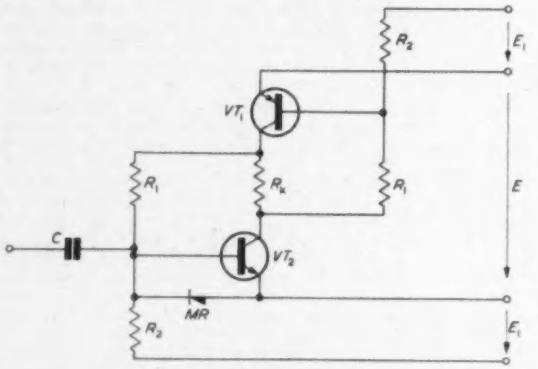

Fig. 2. The bistable circuit

Bistable Operation

By connecting the bases and the collectors as in Fig. 2 a circuit is obtained which has two stable states. As the circuit has two stable states it is capable of regenerative action because of the incremental negative resistance which appears at any point at which the feedback is interrupted[1]. The mode of operation then depends only on the operating point and on the reactive elements used. It can be seen from Fig. 2 that by proper design of the resistive coupling networks the two stable states can be ensured. In the 'off' state both transistors are cut-off while in the 'on' state both transistors are saturated. The trigger signal may be applied to the base of one transistor through the coupling capacitor C as shown in the diagram. The diode MR overcomes the rectifying effect of the emitter junction.

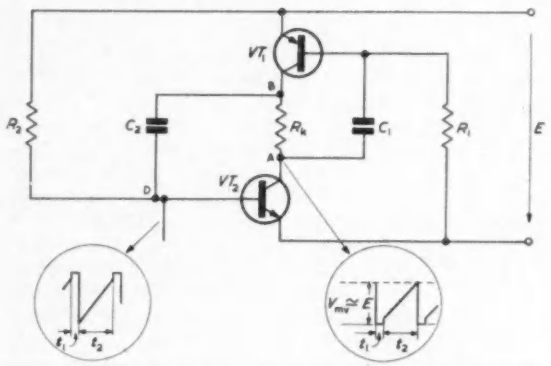

Fig. 3. The astable circuit used for production of the 'phantastron' waveforms

Astable Operation

By replacing the resistors R_1 of the divider by capacitors and connecting the resistors R_2 to a voltage source of opposite polarity, as shown in Fig. 2, the multivibrator circuit of Fig. 3 is obtained. The waveforms obtained at point A are illustrated in Fig. 4.

Starting from the point when both transistors are saturated, the potential at point A is, in practice, zero and the potential at point B equals the supply voltage, E. The charging currents flowing through the coupling capacitors hold the circuit in a quasistable state during the time t_1 (Fig. 3). A small disturbance at point A will change the saturated state of transistor VT_1 and this will be reflected in a lowering of the voltage at point B. In practice a voltage of only 0·15V, caused through regenerative action, will be sufficient to cut off VT_2. Due to the cut-off condition of VT_2 the voltage at point B will continue to fall to nearly zero potential (when $R_k < R_1$). In addition to being collector coupled VT_1 is also base coupled and the effect of this, following time t_1 (Fig. 3) is illustrated in Fig. 4. The emitter circuit is supplied from the supply voltage E and the collector from capacitor C_1. When $R_k \ll R_1 \ll R_2$ the capacitor is discharged at a constant current

* *Vysoká škola technická, Kosice, CSSR.*

$$i_c \simeq \alpha_1 (E/R_1)$$

The charge on C_1 will change by approximately E in the time

$$t_2 = (1/\alpha_1) R_1 C_1.$$

If $t_1 \ll t_2$ the repetition frequency of the multivibrator is

$$f \simeq 1/t_2.$$

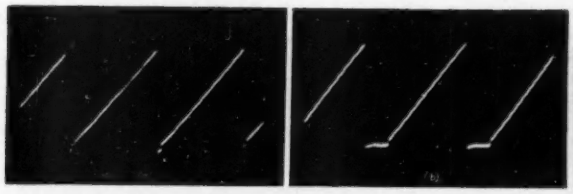

Fig. 4. (a) The oscillogram waveform at point A (Fig. 3)
$R_1 = 112k\Omega$, $R_2 = 200k\Omega$, $R_k = 4k\Omega$, $C_1 = 0{\cdot}025\mu F$, $C_2 = 1\mu F$, $E = 6V$, VT_1—3NU70, VT_2—103rNU70, $f = 350c/s$
(b) Oscillogram at the point A (Fig. 3)
$R_1 = 32k\Omega$, $f = 1kc/s$, further parameters as in the case of the Fig. 4(a)

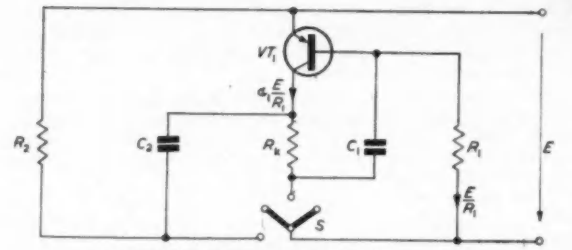

Fig. 5. The equivalent of the circuit in Fig. 3
The transistor VT_2 plays the role of the switch S and the transistor VT_1 the supply of the constant current by which the capacitor C_1 is discharged during the time t_2

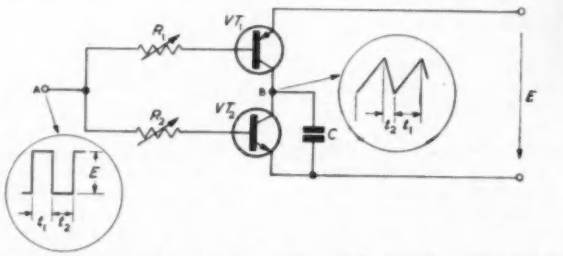

Fig. 6. Collector coupling of complementary pairs for the production of linear waveforms

When the relationship of the capacitors is chosen so that

$$(C_2/C_1) \gg 1$$

then the potential at the base of VT_2 (point D) follows the potential at point B. When the potential at the base of VT_2 reaches zero, regenerative action occurs and the switch S, Fig. 5, is returned to the 'on' state. The charging current of the capacitors C_1 and C_2 saturates the transistors and the original state is established.

The good linearity of the 'Phantastron' waveforms of Fig. 5 is a result of the constant discharging current of the capacitor C_1.

Non-regenerative Action

The output characteristics of junction transistors make it possible to charge or discharge the integrating capacitor C (Fig. 6) without any great dependence of the collector current on the collector voltage at point B. Both the charging and discharging of the capacitor C by VT_2 can be controlled by VT_1 and VT_2 respectively. The special waveforms obtained with this circuit are shown in Fig. 7. More correct results can be obtained when both transistors are operated in the base connexion. Fig. 8 shows the waveform obtained when double integration of the rectangular waveform is provided[3]: the sinusoid consists of two parabolic half-waves with non-zero initial slope.

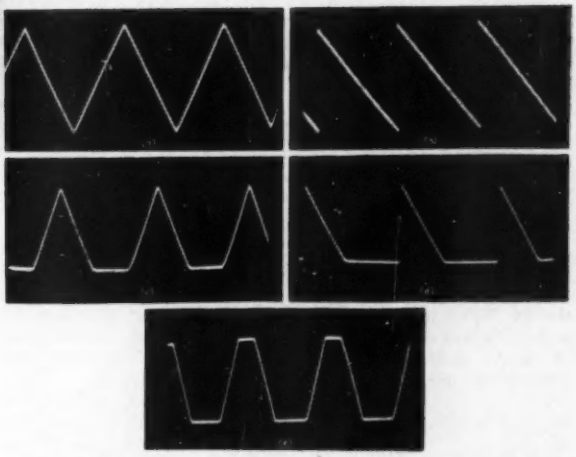

Fig. 7. The waveforms obtained at point D (Fig. 6) achieved by varying the resistance value of the potentiometers R_1, R_2 and also by different mark-to-space ratio t_2/t_1 of the incoming signal

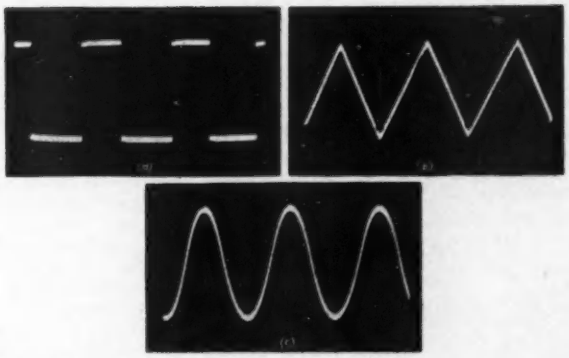

Fig. 8. (a) Incoming signal at point A (Fig. 6)
(b) The output signal at point D
(c) The output signal after further integration with the circuit of Fig. 6

Conclusion

As the above review of collector coupled complementary pair circuits shows they may be found useful for various purposes. Thyratron type characteristics can be obtained in the bistable mode while 'Phantastron' type waveforms can be generated in the astable mode. Triangular waveforms and also multiple integration can be achieved in the non-regenerative mode of operation.

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LETTERS TO THE EDITOR

(We do not hold ourselves responsible for the opinions of our correspondents)

The Transistor as a Temperature-Sensing Device

DEAR SIR,—The article by Mr. Pallett, June, 1961, on the use of transistors as temperature sensing devices states that, due to the approximately exponential character of I_{co} and I_{co}', it is not possible to design a temperature control system with a constant sensitivity. However, if the control band of the controller is relatively narrow which it usually is where close control is required, this is not the case.

If the circuit of Fig. A is considered, then controller "balance" will be achieved at a particular value of VT_1 emitter potential in the region of 7·5V determined largely by the Zener diode in the emitter of VT_2. Under these conditions the controlled temperature is determined by

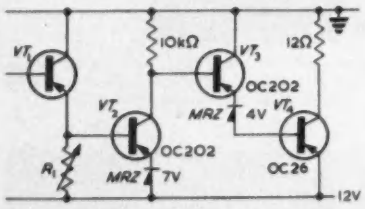


Fig. A. The circuit considered as a temperature controller

the value of R_1 since I_{co}' multiplied by the value of R_1 must equal about 7·5V. Now it is known that the temperature coefficient of I_{co}' for germanium is about 14 per cent/°C, i.e.:

$$(1/I_{co}')\,d\,(I_{co}'/dT) = 0{\cdot}14/°C,$$

and for VT_1 that $I_{co}' = V_{R_1}/R_1$ at balance.

Hence, substituting

$$(R_1/V_{R_1})\,d\,(I_{co}'/dT) = 0{\cdot}14/°C,$$

and on re-arranging, since $RdI = dV$,

$$dV_{R_1}/dT = 0{\cdot}14V_{R_1}/°C.$$

Now in this case $V_{R_1} = 7{\cdot}5V$ and hence $dV_{R_1}/dT = 1{\cdot}05V/°C$, a value which is just as large as that quoted by Mr. Pallett and which is dependent on temperature only in so far as dI_{co}'/dT is dependent on temperature and as Mr. Pallett's Fig. 4 shows, this dependence is small.

The difficulties caused by surface leakage can be largely overcome by substituting a transistor having a larger junction area in place of the OC71, the OC72 or OC26 being suitable and the OC26 having the advantage that OC200's can be substituted for the OC202's since the I_{co}' of the OC26 is high enough to cope with the reduced sensitivity this change produces.

Finally, this circuit places the collector of the thermometer at the same potential as one end of the bath heater which is always advantageous.

Yours faithfully,

D. SHAW,
The United Steel Companies Ltd.,
Rotherham.

The author replies:

DEAR SIR,—I do not think that the common collector circuit has previously been used for sensing temperature and I agree that it will have a sensitivity which is independent of operating temperature. However, I think that Mr. Shaw's circuit suffers from some disadvantages which the common-base circuit avoids. With his arrangement the temperature at which the system is controlled is set by varying R_1. This register will be related to temperature by an exponential law, but, for the common base circuit, the control resistor is linearly related to temperature. At low operating temperatures the current through VT_1 will be very small and R_1 will have a high value. Under these conditions the circuit may be susceptible to electrical interference and effects due to surface leakage. I do not know whether the use of a large area transistor such as the OC26 type would reduce surface effects but recently the methods which use the variation of I_{co} with temperature have been criticized by Verster[1]. He has shown that long term changes of I_{co} do occur, following a temperature change.

For the common base circuit the collector current may be set to any convenient value consistent with the power rating of the transistor and can be made large compared with surface leakage current even for operating temperatures far below normal ambient temperatures. The current through the sensing transistor, and the power dissipated, remain almost independent of the temperature at which the system is controlled over a very wide range.

I suggest, therefore, that the use of Mr. Shaw's circuit will be limited to fairly high temperatures and the circuit which I described may have a wider field of application.

Yours faithfully,

J. E. PALLETT,
Post Graduate Medical School,
London, W.12.

REFERENCE

1. VERSTER, T. C. Thermal Transient Effects on Junction Transistors. *J. Electronics and Control 10*, 191 (1961).

A Quick Method for Calculating Transistor Amplifier Circuits

DEAR SIR,—In their article which appeared in *Electronic Engineering*, June 1961, Vierhout and Vendrik give formulae for the calculation of the noise generated by a transistor input stage from the magnitudes of two fictitious generators included in the transistor input circuit. While it is true that a noisy transistor may be represented by a noiseless transistor in the input circuit of which are connected a constant voltage noise generator of magnitude V volts r.m.s. and a constant current generator of magnitude I amperes r.m.s., these generators are not in general completely uncorrelated, as these authors assume[1].

If account is taken of any correlation between the two generators, a further term must be included in equation (13a) so that the formula becomes

$$N = (V_{tr}^2 + 2kV_{tr}I_{tr}R_s + I_{tr}^2R_s^2)\left(\frac{r_i}{r_i + R_s}\right)$$

where R_s is the reflected source resistance $= n^2R_i$

N is the total noise in mean square volts referred to the transistor input terminals

k is a coefficient which depends on the correlation between the two generators and which will lie between 0 (for uncorrelated sources) and ±1 (for fully correlated sources).

This does not affect the validity of the authors' conclusion that an optimum signal-to-noise ratio is obtained when $R_s = V_{tr}/I_{tr}$, but does affect the value of the noise calculated for this condition. For example, taking previously published figures[2] for the OC71 with $I_c = 500\mu A$ and a bandwidth of 50c/s to 19kc/s:

$V_{tr} = 0{\cdot}65 \times 10^{-6}$ V r.m.s.

$I_{tr} = 1{\cdot}36 \times 10^{-9}$ A r.m.s.

$k = +0{\cdot}73$

$R_{in} = 2{\cdot}0k\Omega$

the factor F calculated for an optimum source resistance of $R^* = V_{tr}/I_{tr} = 480\Omega$ becomes

$$F = \frac{(4{\cdot}2 + 6{\cdot}2 + 4{\cdot}3) \times 10^{-13} + 1{\cdot}5 \times 10^{-13}}{1{\cdot}5 \times 10^{-13}}$$

$$= 11$$

which is in good agreement with the author's stated value for F of about 11. It will be seen, however, that the term in $kV_{tr}I_{tr}$ is not negligible compared with those in V_{tr}^2 and I_{tr}^2. Furthermore, it will be seen that it is disputable whether the

optimum source resistance $R^* = 480\Omega$ is 'nearly equal to the input impedance of the transistor', which for this value of collector current is 2·0kΩ.

Finally, it should be emphasized that the values of V_{tr}, I_{tr} and k vary rapidly with collector current as well as with bandwidth.

Yours faithfully,

C. K. BATTYE,

Physics Department,
Guys Hospital,
London.

REFERENCES

1. MONTGOMERY, H. C. Transistor Noise in Circuit Applications. *Proc. Inst. Radio Engrs. 40*, 1461 (1952).
2. BATTYE, C. K., GEORGE, R. E. Transistors as Low Noise Amplifiers. *Proc. Instn. Elect. Engrs. 106B*, 1190 (1959).

The authors' reply:

DEAR SIR,—In reply to the comment by Mr. Battye we would like to emphasize the aim of our article, namely to provide the designer with a quick method of calculation.

It is very difficult for the designer to obtain the value of the correlation coefficient k and usually also the value of the optimum resistance R^*, because these values are seldom mentioned in the transistor data published by the manufacturers. Mostly only the noise factor F or the noise figure $10^{10}\log F$ is given.

Knowing only F the designer has to estimate R^* and we advise choosing for it the input impedance r_i of the transistor. Of course this input impedance depends on the operating point. It is best to choose R^* at moderate collector-currents, as mentioned in the article (i.e. 500 to 1 000Ω).

With our calculations the designer arrives at values of V_{tr} and I_{tr} which are somewhat higher than the real values.

Neglecting the term k the calculations with raised figures for V_{tr} and I_{tr} show about the same noise value as the exact calculation.

Similar approximations are often made in calculations with valves. For instance, valve noise is given as an equivalent noisy resistance at the grid input, though one knows that this is not exact.

Yours faithfully,

R. R. VIERHOUT and
A. J. H. VENDRIK,
R.C. University,
Holland.

PUBLICATIONS RECEIVED

TRADING OPPORTUNITIES IN WEST GERMANY is the second report issued by the Export Council for Europe. The first report, published in May, described the market openings in nine countries in Western Europe and was entitled "Trading Opportunities in Europe (Part One)". The second report is devoted entirely to West Germany. Copies of the report are available from Export Council for Europe, 21 Tothill Street, London, S.W.1, price 5s.

SELECTION CHART is the title of a new brochure presenting the precision wirewound resistor data of Alma Components. The resistor types are tabulated in charts according to the particular requirement of design. Enquiries should be addressed to the Sales Director, Alma Components Limited, 551 Holloway Road, N.19.

OPPORTUNITIES FOR INDUSTRIAL INVESTMENT IN WESTERN AUSTRALIA is a report by a team of British industrialists who visited Western Australia in October 1960 at the invitation of the State Government. The objectives of the visit were to investigate opportunities to establish new industrial capacity, and generally to stimulate wider interest in the United Kingdom in the development of secondary industries in Western Australia. Further information may be obtained from the Agent General's Office for Western Australia, Savoy House, 115 Strand, W.C.2.

RADIO VALVE DATA is the seventh edition of this reference book containing the characteristics of over four thousand valves, transistors, rectifiers and cathode-ray tubes. The book, compiled by "Wireless World", is published by Iliffe Books Limited, price 6s. net (6s. 10d. by post).

SINTOX TECHNICAL INFORMATION AND DATA are now available in the form of a brochure describing the high-alumina ceramic material manufactured by Lodge Plugs Ltd. Copies may be obtained from the Company at Rugby.

PHOTOELASTICITY PRINCIPLES AND METHODS by H. T. Jessop and F. C. Harris is a Dover edition, first published in 1960 from the original edition published by Cleaver-Hume Press Limited in 1949. The book in paperbound form costs $2.00 from Dover Publications Inc., New York.

LETTER SYMBOLS FOR LIGHT-CURRENT SEMICONDUCTOR DEVICES (mainly for use in catalogues and similar technical literature) B.S. 3363:1961 has now been published and is available from the British Standards Institution at British Standards House, 2 Park Street, London, W.1. Price 5s.

BULLETIN OF ELECTRICAL ENGINEERING EDUCATION is published twice yearly in June and December at a subscription rate of 10s. 6d. per annum by the College of Science and Technology, Manchester.

TELEVISION IN EDUCATION is the title of a publication describing the E.M.I. "packaged" television station which is intended to solve the problem of the acute shortage of trained teachers in educational fields. A copy of this leaflet is available on application to the Broadcast Equipment Division, E.M.I. Electronics Ltd, Hayes, Middlesex.

ELECTRONIC-VALVE BASES, CAPS AND HOLDERS is British Standard No. 448 for which two more sections have been published, B8D/3 and 7/3. They lay down dimensions for valve-holders and for the gauges needed to ensure compatibility with the appropriate valves. Copies of these sections, which are published separately, can be obtained from the British Standards Institution, Sales Branch, 2 Park Street, W.1, price 3s. each.

CATALOGUE SUPPLEMENT May 1961 has been produced to bring holders of the Belling and Lee 1959-60 edition up to date with information concerning components, pending the publication of a completely new edition, which they hope to publish next year. Copies of the publication are available on request to Belling and Lee Ltd, Great Cambridge Road, Enfield, Middlesex.

MODERN PHYSICS by L. R. B. Elton and Daphne F. Jackson is the fourth edition of this booklet designed to bring together some of the formulae in Modern Physics which are frequently required by students. The standard of the book is somewhat above that of a Pass or General degree: it should therefore serve students taking either a Pass or an Honours degree. The booklet is published by Sir Isaac Pitman and Sons Ltd and costs 2s.

MECHANICAL WORLD ELECTRICAL YEAR BOOK 1961 contains a new section on precision measurement, together with information on a wide range of subjects including the use of cold-formed sections in structural design, gas turbines, materials, power plant, machine tool, presswork, pumps, etc. The book is published by Emmott and Co. Ltd, 31 King Street West, Manchester, 3. Price 4s.

MECHANICAL WORLD YEAR BOOK 1961 presents a series of tables and notes summarising under specific headings the available methods for direct and comparative measurement. The book is published by Emmott and Co. Ltd, 31 King Street West, Manchester, 3. Price 5s.

SHIELDS FOR ELECTRONIC TUBES AND VALVES: Part 1, General requirements and tests (B.S. 2258: Part 1: 1961) applies to shields for electronic valves of the type included in B.S. 448 'Electronic-valve bases, caps and holders'. Its scope is limited to valve shields compatible with valveholders for telecommunication and applied electronic equipment, which is in the course of preparation. Copies of the standard may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. Price 5s.

RMB HANDBOOK, an Anniversary Edition published by Miniature Bearings Ltd, is intended as a guide and contains 100 pages of information and reference materials of interest to precision engineers. Enquiries should be addressed to the Company at the following address: 39 Parliament Street, Westminster, London, S.W.1.

I.E.E. ANNUAL REPORT FOR 1960-61 is the Council's report to members for the year ending 31st March 1961, presented at the Annual General Meeting of the Institution of Electrical Engineers, Savoy Place, London, W.C.2, on 18 May, 1961.

TELECOMMUNICATION COMPONENTS (B.S. 2133B: Part 1: 1961 and B.S. 2136: Part 1: 1961) are two more British Standards in the series for components intended primarily for use in telecommunication and allied electronic equipment. These standards provide manufacturers and users with a means of judging the capacitors' suitability for use over stated ranges of temperature and humidity, their ability to withstand mechanical shock and the kind to be expected in transit or in operation, and their ability to remain unharmed by normal assembly processes, such as soldering. Each standard specifies different requirements for various grades of capacitors according to the climatic environment in which they are intended for use. Copies can be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. Price 12s. 6d. each.

ELECTRONIC COMPONENTS manufactured by Electrosil Limited are described in a new release issued recently by the Company. Enquiries regarding the Company's product range should be addressed to the General Manager, Electrosil Limited, Colnbrook By-Pass, Colnbrook, Slough, Bucks.

RADIO HEATERS LTD of Wokingham, Berks, have recently published details of their vacuum and gas crystal pullers. Full details of the equipment are given in a leaflet and requests for copies should be addressed to Publicity Department, Radio Heaters Ltd, Eastheath Avenue, Wokingham, Berks.

BRITISH STANDARD FOR CRIMPED JOINTS (NON-INSULATED) FOR GENERAL PURPOSE ELECTRICAL CABLES FOR AIRCRAFT (G. 178) provides details of the requirements of aircraft constructors and operators for crimping non-insulated connexions. The Standard deals with the completed joints and, in part, with tools and terminal ends which it is intended will be the subject of more detailed standards in due course. Copies may be obtained from the British Standards Institution, Sales Branch, 2 Park Street, London, W.1. Price 6s.

"BELLING-LEE" have recently published two leaflets entitled 'Collecon and Camlecon Connectors', and 'Prestincert' which is the name given to the principle of counting components of all kinds on panels and chassis of any material. Enquiries should be addressed to Belling and Lee Ltd, Great Cambridge Road, Enfield, Middx.

BOOK REVIEWS

Linear Graphs and Electrical Networks

By S. Seshu and M. B. Reed. 315 pp. 134 figs. Med. 8vo. Addison-Wesley Publishing Co. Inc., New York and London. 1961. Price 74s.

THE theory of linear graphs has its origin in the celebrated memoir presented by the Swiss mathematician Euler to the St. Petersburg Academy in 1736 in which he solved the problem of the seven bridges of Königsberg. At the mouth of the River Pregel, where the town of Königsberg is situated, there are two islands which were connected each to the other and each to the mainland by seven bridges. Early in the eighteenth century the inhabitants of Königsberg amused themselves with the problem of how to plan a walk in the town such that each bridge was crossed once and once only. Euler represented the system of bridges by a topological line diagram now known as a linear graph. By investigating the properties of linear graphs he not only proved the impossibility of planning such a walk in Königsberg but established the theory of unicursal curves and thus initiated the science which Listing later called topology. (In recent years an eighth bridge has been built in Königsberg and it is now possible to cross every bridge once, and once only, provided one begins and ends the journey on an island.) The first application of linear graph theory to the study of electrical networks appears in a paper published in 1847 by Kirchhoff which, according to the topologist Veblen, "is doubtless the first important contribution to the theory of linear graphs".

Despite Kirchhoff's recognition of the relevance of linear graph theory to the study of network behaviour, it is only in recent years that the importance of the combinatorial aspect of the subject has been fully realized. Considerable attention has lately been directed to the development of graph theory as an aid to network analysis and synthesis and the authors of this new book have contributed significantly to this effort.

As applied to the study of networks, linear graph theory is concerned only with the way in which electrical elements are interconnected to form a network; the purely electrical properties of the elements are ignored. A linear graph is an assemblage of points in space interconnected by line segments and its purpose is to chart the flow of electric charge in the corresponding physical network. To account for the direction of the flow of charge, each line segment of the graph is oriented and the graph is said to be directed. However, because non-directed graphs have recently found application in such subjects as the theory of contact networks, the authors begin their book with a study of graphs with non-oriented line segments. The specification of such graphs by incidence, circuit, and cut-set matrices with components over the field modulo 2 is explained and the properties of these matrices are considered in terms of linear vector spaces. The theory of directed graphs is then introduced and the discussion includes a study of the conditions under which a given matrix of integers modulo 2 represents a linear graph. This problem arises in the theory of topological network synthesis.

Pure linear graph theory occupies five of the book's ten chapters. The next three chapters are concerned with the application of this theory to the analysis and synthesis of electrical networks. Among the many topics discussed are energy functions, stability, duality, and the use of topological methods for the direct determination of network response. The treatment concludes with a review of the work which has so far been done on the use of graph theory in network synthesis. The penultimate chapter deals with the application of graph theory to contact networks, sequential switching systems, and logic network realizations of Boolean functions. The final chapter contains a brief indication of applications to communication systems, Mason and Coates flow graphs, the calculus of binary relations, and axiomatics.

The book is among the first to be devoted entirely to the topological approach to networks. It is lucidly written and it is difficult to find an aspect of the subject which has not been covered. In addition to problem lists at the end of each chapter there is a list of outstanding network graph problems and an extensive list of references. As in all recent publications on topological network theory a notable omission in the list of references is the paper *On the flow of electricity in a system of linear conductors* by Sir Joseph Larmor (*Proc. London Math. Soc. 26*, 262 (1885)). It is not all network theorists who believe that linear graph topology is the most natural basis for electrical network theory but, to those who do, this book can be thoroughly recommended.

S. R. DEARDS

Fundamentals of Electronics

By M. Mandl. 574 pp. 323 figs. Medium 8vo. Prentice Hall International Inc. 1961. Price 50s.

THE word "fundamental" in the title of this volume is somewhat misleading as the book is in effect an introductory text in electronics written in a popular style. The treatment is essentially non-mathematical and even the simplest ideas are explained very fully with the aid of examples and diagrams. A book of this type is unlikely to appeal to a student undertaking a serious course of study but may well be useful to a reader of modest attainments who finds conventional textbooks too difficult to follow. The book originates in the U.S.A. and, as is sometimes found in popular textbooks from that country, the direction of current flow is taken as being the same as that of electrons, i.e. to the positive battery pole. This is likely to give rise to difficulties later on as not only must the flux-current rules be reversed but the conventional direction is invariably used in books and articles dealing with transistors. Approximately one-third of the book deals with simple ideas of voltage, current and power, followed by an introduction to a.c. circuits. Thermionic valves and transistors are then considered fairly briefly and the remainder of the book is devoted to applications such as amplifiers, oscillators and radio-receivers. The book is not free from error, for example, photo-electric emission is illustrated by a photo-voltaic cell (p. 24), the action of a *CR* network is incorrect (p. 412) and a negative-resistance transistor oscillator is shown (p. 402) without mentioning that the circuit uses the special properties of the now obsolete point-contact device. However, the author has succeeded in explaining some of the elementary facts of electronics with the aid of very little mathematics and for this reason the book may well be useful to a reader of limited mathematical ability.

V. H. ATTREE

Computer Logic

By I. Flores. 458 pp. 185 figs. Medium 8vo. Prentice Hall International Inc. 1961. Price 45s.

THERE is not a valve, not a transistor, not a diode to be found in this book on electronic computers. This should not deter any electronic engineer interested in this field from buying it. On the contrary; by wisely refraining from wasting space on subjects that are adequately dealt with elsewhere, the author has been able to concentrate on those universal aspects of computers that are independent of their particular hardware realization: the logical and functional co-operation of their elements, their application, and their method of use. From an analysis of elementary arithmetic operations and an introduction to Boolean algebra, Venn diagrams, Karnaugh maps and symbols for logical relations, the reader is lead, step by step, to the logical flow diagrams of the various units and building blocks comprising a computer—counters, shift registers, adders, multipliers, stores, control units etc.—and their integration in the complete machine; from an explanation of how to code a simple instruction and the idea of cycles and loops the student progresses to a stage where he is able to

code a complicated programme (the computation of an auto-correlation function). The hardware aspect is by no means neglected entirely; there are excellent perspective drawings showing the interconnexion of magnetic core memories and the essential mechanical details of tape readers and printers.

The book ends with a 50-page glossary of technical terms, a bibliography and an index. It is printed clearly on good quality paper and the price is reasonable. It can be strongly recommended to anyone who wants to know (in the words of the dust jacket) how computers are put together, how they work and how to use them.

D. G. PRINZ

Magnetic Tape Instrumentation

By G. L. Davies. 263 pp. 86 figs. Medium 8vo. McGraw-Hill Book Co. 1961. Price 66s.

WITHIN this book the author has assembled much useful information relating to the techniques and equipment used for magnetic recording and reproduction of data. It is considered to be of value to those associated with magnetic tape instrumentation—a term favoured by the author—whether by design, manufacture or use, but it is not intended for those whose interests may lie solely in theoretical treatise or mathematical manipulation with incidental reference to current practice. The fundamentals of this art are outlined in the 19 pages comprising Chapter 2 and also serve as an introduction to the description of techniques, systems and component parts dealt with subsequently.

Chapter 1 arouses interest with a brief account of the most common applications of magnetic tape and drum equipments. It may cause surprise to learn that this medium was used to preserve a record of rudder deflexion during flight test, as early as 1936, and that the equipment available today has a similar performance to that designed in 1948. The third chapter is devoted to a description of the variety of techniques used and is easily read by those familiar with the basic concepts. Perhaps in the interests of simplicity, no mention is made of the secondary gap effects revealed at low frequencies when replaying direct recordings, of the difficulties in design of filters having the precise frequency and phase response demanded by a f.m. system and the use of p.w.m. as a continuous carrier system is abruptly dismissed without emphasis of the inherent superior accuracy of the technique when handling quasi-d.c. signals.

Tape transport mechanisms are adequately described, a separate chapter being devoted to the causes and correction of flutter and skew, these motional irregularities being mathematically analysed in the two appendices. The paraphase "It profiteth a man little to gain minimum flutter and forever lose his data by rough tape handling" is typical of the good advice offered. The short chapter on speed control systems serves its purpose but the treatment of the electronic devices which form an essential part of any instrumentation system leaves many pertinent questions unanswered: Which factors have most influence on the choice of carrier frequency and deviation in a f.m. system? How does one determine the optimum pulse repetition frequency and time excursions in a p.w.m. system?

The author appears to accept American standards or practices on these subjects without attempting justification, yet has non-conformist views regarding the logical sequence of tape speeds and launches a passionate attack on interleaving head stacks which are in widespread use. The description of digital circuits is comprehensive, but may cause the binary tiro to scurry towards a reference library before obtaining a thorough understanding of the subject matter.

Each chapter contains references to American works and a good bibliography is appended to the section dealing with magnetic tape systems; to obtain some of these detailed expositions may cause a British librarian difficulty.

The chapter dealing with magnetic heads is notable for the excellent discussion on crosstalk and its effects on the systems previously described. Finally, magnetic drums and coated disks are examined with reference to their application in the fields of digital storage, time translation and delay devices, the latter finding widespread use in auto-correllation computations.

G. W. DISBREY

Microwave Antennas

By A. Z. Fradin. Translated from the Russian by Morton Nadler; translation edited by R. C. Glass. 668 pp. 291 figs. Med. 8vo. Pergamon Press. 1961. Price £5 5s. 0d.

THIS book is a translation from the Russian by an American and has been edited by an Englishman: thanks, we may assume, to this double process, the text reads well, although the publishers note of apology for the high price and poor quality of the production is amply called for. The book is a revision and expansion of an earlier work by the author, and is meant to deal comprehensively with microwave antenna theory and design, with due weight given to recent achievements.

This vast field is tackled with a truly Teutonic thoroughness. Chapter one, for instance, on classification structure and operating principles, begins by laying down six main types (horn, lens, slot, dielectric, reflector and surface wave antennas): each of these is sub-divided into several forms, and the forms into variants, of which 34 are listed in a family tree. We pass on to the fundamental problem in antenna theory, to methods, both rigorous and approximate, for its solution, and to the solution of diffraction problems by approximate methods. Thus the stage is set for a detailed and up-to-date account of each of the six main types: only the chapter on surface waves (thirty pages) falls short of fifty to eighty pages.

EE 36 108 *for further details*

CHAPMAN & HALL

Two Books from
REINHOLD PUBLISHING CORPORATION

★

The Encyclopedia of Microscopy
Edited by G. L. CLARK

An indispensable reference work. Surveys the broad field of microscopy, including every conceivable aspect of electron, electron mirror and field emission microscopy. *Illustrated* 200*s*.

Static Relays for Electronic Circuits
Edited by R. F. BLAKE

A comprehensive summary of the present state of the art for the equipment designer, the student, and the static relay designer. *Illustrated* 63*s*.

37 ESSEX STREET, LONDON, W.C.2

This is emphatically a book only for the serious, and mathematically minded, reader, who should be eagle eyed, and very patient, if he is to profit fully from the many graphs, most of which are unintelligible without reference to the text. It is here, in the graphs and figures, which are rather small and scrappy anyway, that one longs for better reproduction. The index, of less than two pages, is farcical in a book of this size, and the 67 references, two thirds of them to Russian publications, hardly constitute "a most useful bibliography", as the publishers claim.

To sum up, this book will interest not so much the practical aerial designer as a very few theoreticians; for those few its detail, rigour and topicality may well outweigh the serious defects listed above.

J. B. SCANLAN

Schwankungsercheinungen in Elektronenröhren (Random Fluctuations in Thermionic Valves)

By Franz Ollendorff. 468 pp. 341 figs. Crown 4to. Springer Verlag, Germany. 1961. Price £8 3s. 6d.

THIS book is based on lectures read by the author for advanced students; however, its contents belong substantially to the subject matter of a standard four-year course of university studies in electronics. Beyond this circle the book may be welcomed by practising electronic engineers to whom it may be of assistance in their own development work.

ELECTRONIC EQUIPMENT

A description, compiled from information supplied by the manufacturers, of new components, accessories and test instruments.

(Voir page 541 pour la traduction en français ; Deutsche Übersetzung Seite 548)

ELECTRIC FIELD PLOTTER

George Kelk Ltd, 5 Lesmill Road, Don Mills, Ontario, Canada

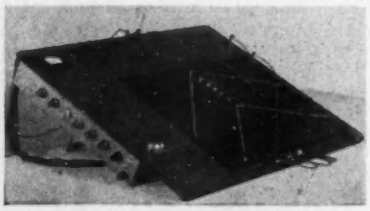
(Illustrated below)

The Kelk electric field plotter model F103A is a self-contained device for the solution by rheo-electrical analogy, of problems involving the Laplace field equation, such as those relating to heat and fluid flow and electrostatic or magnetic fields.

The plotter consists of a flat 4ft² plotting board with built-in bridge unit and power supply, centre-zero balance meter, and controls.

To use the plotter, conductive paper is placed on the plotting area and the subject under investigation is simulated by low-resistance conductors painted on the paper.

Boundary potentials and up to five intermediate forcing potentials are set up by individual ten-turn potentiometers. These potentials are applied through suitable-terminated leads to the conductive elements to establish a two-dimensional electrical analogy of the physical subject and associated field patterns.



A stylus connected to a high-resolution null-balancing circuit in the bridge unit is used in conjunction with the balance meter to explore the conductive paper surface. In this way electric field contours can be investigated and plotted to represent their physical counterparts.

The plotter offers a resolution of 0·05 per cent of the total field and bridge linearity of 0·1 per cent. Power required is 115V, 60c/s, 15W for the standard version. Units can be supplied for use with other voltages and frequencies.

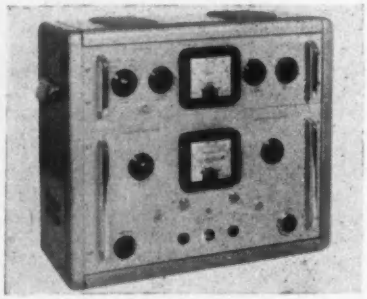
EE 36 751 *for further details*

KLYSTRON POWER SUPPLY

Mid-Century Microwavegear Ltd, 19 Parsons Mead, West Croydon, Surrey

(Illustrated above right)

The klystron power supply type EE/4 is a high voltage supply for operating K-Band and Q-Band klystrons. The resonator voltage can be varied from 1·75 to 2·25kV, at a maximum current



of 20mA, the reflector can be from 50 to 450V negative with respect to cathode, and the grid can be up to 200V negative. The heater supply is direct current, stabilized at 6·3V, and up to 1·2A. All supplies are highly stabilized and ripple-free. Internal modulation facilities provided are squarewave of 3kc/s which can be applied to either grid or reflector, and a 50c/s sawtooth which can be applied to the reflector only. External modulation waveforms can be applied to either electrode. All controls are mounted on the front panel, together with meters for reading resonator voltage and current, and reflector voltage and a six-way Plessey socket for the klystron connexions.

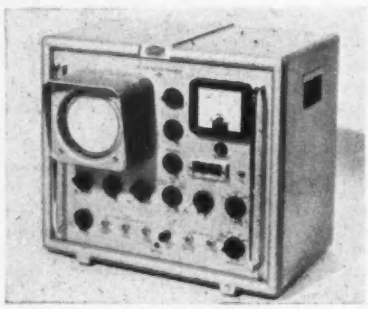
EE 36 752 *for further details*

V.L.F. PHASE METER

Airmec Ltd, High Wycombe, Buckinghamshire

(Illustrated below)

This instrument has been designed for the accurate measurement of phase-angles in the frequency range 0·01c/s to 1kc/s. The indication is direct, and takes the form of a brightened spot on the face of a long-persistence cathode-ray tube with a circular time-base. Once the necessary preliminaries have been carried out, a reading of phase-angle may be obtained in one cycle of the input voltage.



Facilities are provided for displaying Lissajous figures, and for cancelling out the d.c. component in the unknown waveform. In addition, the amplitude may be measured by means of the d.c. shift technique.

The reference and quadrature signals required by the phase meter may be obtained from the Airmec v.l.f. signal generator type 257 over the frequency range common to both instruments viz: 0·03 to 30c/s. Within these limits the two instruments together form a versatile combination of particular interest to workers in the servo and process control fields.

EE 36 753 *for further details*

DECADE RESISTANCE BOX

Levell Electronics Ltd, 10-12 St. Albans Road, Barnet, Hertfordshire

(Illustrated below)

This inexpensive resistance box contains Erie high stability resistors of the fully tropical insulated cracked carbon variety. The resistors are initially selected to within 1 per cent and the design is

such that the resistance in circuit is always determined by at least two individual resistors.

Four decade controls are provided by 11 position rotary switches fitted with pointer knobs. The switches have positive indexing and the contacts operate on the knife action principle.

The change of resistance from one switch position to the next is clearly defined without the occurrence of any intermediate value or open-circuit condition.

The resistors are completely enclosed within a metal case which is connected to a separate shield terminal.

The resistance range of the box is 10Ω to 111·1kΩ in intervals of 10Ω with an accuracy of ±1 per cent at any selected value. The power rating is 3W at 43°C and 2W at 70°C, the temperature co-efficient being less than 0·05 per cent/°C.

EE 36 754 *for further details*

The HF 156 Manpack Wireless Set

JH&P

Now approved for the British Army

THE HF156 manpack transmitter/receiver is a thoroughly reliable, robust, fully sealed and entirely self-contained portable set for active service in extreme climatic conditions. Six crystal-controlled channels, extreme simplicity of operation and exceptional range on voice and CW are some of the many features that stood out during extensive user trials in the Far East. The military-type one-man canvas pack in the picture above contains the combined transmitter/receiver and power supply and the aerial loading unit. A pocket contains handset, morse key and headset with boom microphone when they are not in use. A sectional rod aerial and its flexible base are also carried. Dipole and end-fed aerials, in a separate haversack, need be carried only when required. Provision is also made for vehicle-borne operation and for the use of non-spillable lead/acid accumulators or dry batteries, greatly increasing the versatility of this latest set in the BCC HF15 series.

Ask for a leaflet describing the HF156 and the additional facilities for vehicle-borne operation and for power supply from lead/acid accumulators or dry batteries.

*

BCC also design, engineer, instal and service complete communications systems. Our advisory service would be glad to have the opportunity of helping you.

BCC

*

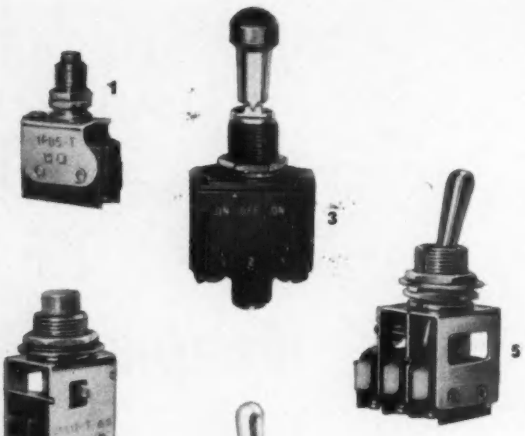
BRITISH COMMUNICATIONS CORPORATION LIMITED

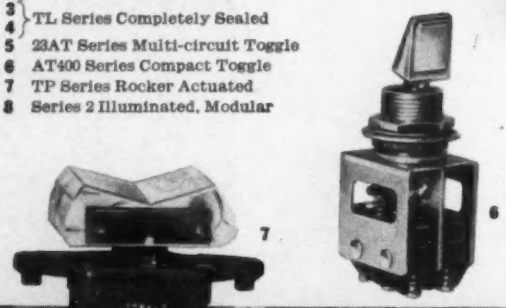
HIGH WYCOMBE BUCKS — TEL : HIGH WYCOMBE 2501

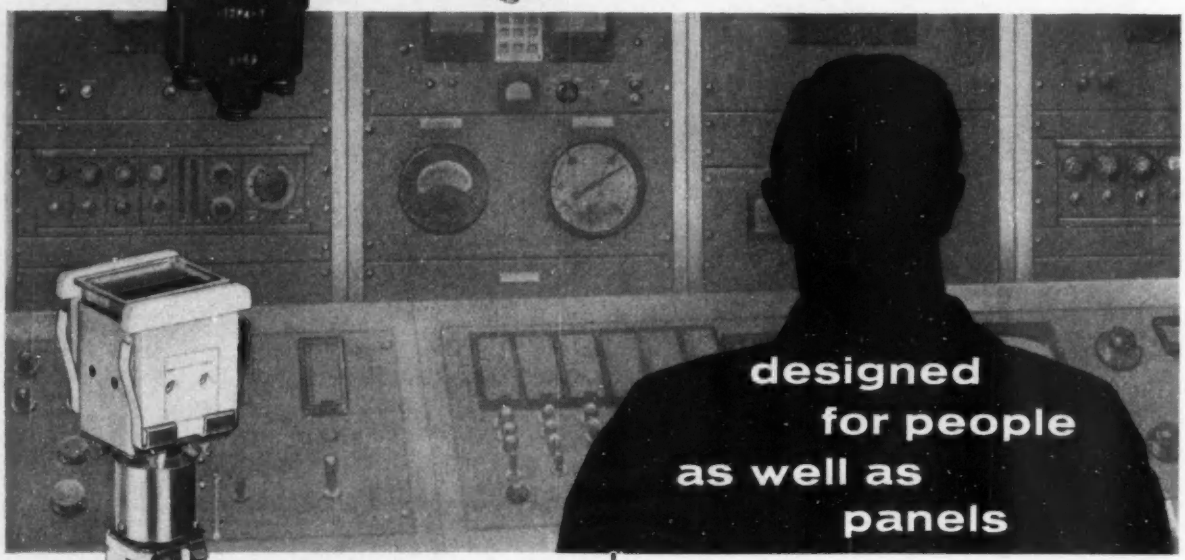
Grams : BeeCeeCee High Wycombe — And at Wembley

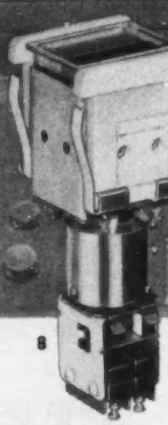
All Honeywell Pushbutton and Toggle Switches
are designed with the user in mind.
Their positive 'feel', positive action
and ease of labelling make it difficult
for the user to make mistakes on the panel.
They offer a long trouble-free life
with a wide variety of circuitry
and electrical ratings . . .
an outstanding range of precision switches,
superb 'human-factors' engineering.

1, 2 } PB Series Subminiature
3, 4 } TL Series Completely Sealed
5 23AT Series Multi-circuit Toggle
6 AT400 Series Compact Toggle
7 TP Series Rocker Actuated
8 Series 2 Illuminated, Modular









WRITE OR SEND THE COUPON TODAY to Honeywell Controls Limited, Greenford, Middlesex. Waxlow 2333

I am interested in using pushbutton or toggle switches for .....(state application)

Please send me full information

Name .....

Company .....

Position .....

Address .....

..... EE

Sales Offices in the principal towns and cities in the United Kingdom and throughout the world.

Honeywell

First in Micro Switches

HIGH VALUE RESISTORS

Alma Components Ltd, 551 Holloway Road, London, N.19

These resistors have been developed using very fine wire to enable very high values to be wound to close tolerances in as small a space as possible.

The former is made from non-hygroscopic ceramic with high insulation properties and great mechanical strength. The coating is an epoxy resin, clinging tightly to the former and wire to ensure protection against humidity over the range 0°C to 100°C.

Known as the type E, the resistor is available from 100kΩ to 10MΩ to a tolerance of ±0·05 per cent, and a temperature coefficient of better than ±0·002 per cent/°C.

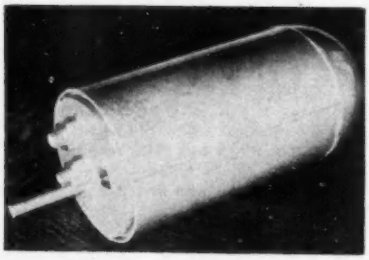
EE 36 755 *for further details*

IONIZATION CHAMBER

Plessey Nucleonics Ltd, Weedon Road, Northampton

(Illustrated below)

The PN1 is an ionization chamber with a sensitive volume of 5 litres. The use of ceramic insulators and ceramic-metal seals provides great robustness and in addition the rigid electrode structure gives low microphony. A wide range of



filling gases can be provided at pressures up to 20 atm.

The energy response to gamma radiation may be made level down to about 100keV, below which it falls sharply, by the use of a mixed argon-nitrogen filling, developed by AERE, Harwell. The chamber may be made sensitive to thermal neutrons if required, and can be filled to provide approximate tissue equivalence to fast neutrons over a wide energy range.

An epoxy resin paint finish is normally supplied and the base plate of the chamber is suitable for making a sealed joint to a head amplifier case.

EE 36 756 *for further details*

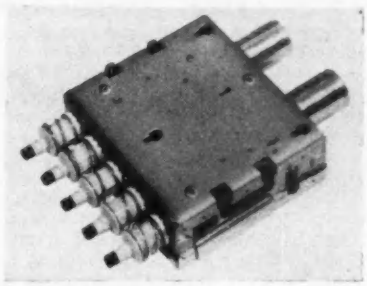
PUSH-BUTTON TELEVISION TUNER

Sydney S. Bird & Sons Ltd, Palace Mansions, Palace Gardens, Enfield, Middlesex

(Illustrated above right)

The basic circuit of this incremental push-button tuner comprises an r.f. amplifier and a local oscillator/mixer. The i.f. output from the anode circuit being brought out for bottom end capacitive coupling to the receiver i.f. amplifier.

Pre-setting of the channel selection buttons to any frequency is a user operation, and only requires that the button is rotated to one of its clock-indexed positions. Subsequent depression of the button selects the channel by moving ganged shorting links to the pre-determined position along the incremental inductors.



Variants of the basic four button tuner provide additional buttons affording continuously tuned v.h.f./f.m. in Band II, and a switched injection point, at the grid of the mixer for the introduction of the output from a separate u.h.f. tuner.

The PC.80 tuner incorporates a 'memory' type oscillator fine tuner. Each button embodies a coaxial control for optimum setting of the local oscillator frequency for the channel pre-set to it. The fine tuner setting for each button is entirely independent of the setting for other buttons. This feature, together with the long term stability of the oscillator circuit and the accuracy of re-setting, ensures minimum operation of the fine tuner by the user.

EE 36 757 *for further details*

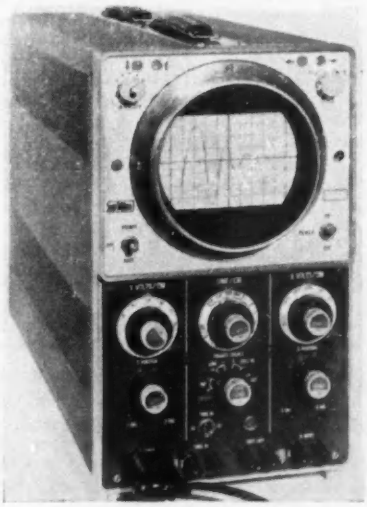
STORAGE OSCILLOSCOPE

Distributed by: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Illustrated below)

Aveley Electric Limited have introduced into the U.K. a new Dumont storage oscilloscope type 430.

This oscilloscope is a compact one-piece unit with identical X-Y amplifiers,



of high sensitivity and frequency range from d.c. to 10kc/s.

Generally speaking, the instrument can be classified as an X-Y Plotter with a 10kc/s bandwith. Its larger useable screen ensures greater detail and accuracy and special circuits protect the cathode-ray tube and virtually eliminates all chances of screen damage.

The erase time is 15sec with repeat storage cycles every 60sec and storage time can vary from seconds to days.

The sensitivity of the X and Y amplifier are 10mV/cm to 100V/cm in switched steps, with single or balanced inputs. In the balanced condition, common mode rejection exceeds 40dB. Amplifier phase shift is less than ±1° from d.c. to 3kc/s.

An internal ±1 per cent calibrator is available to calibrate the X and Y amplifiers.

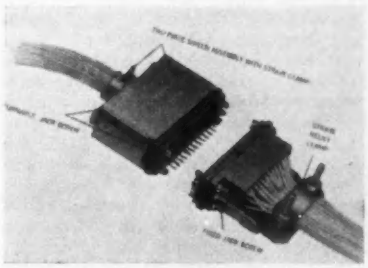
EE 36 758 *for further details*

CRIMPABLE PLUGS & SOCKETS

Aircraft Marine Products (GB) Ltd, Amplo House, 87-89 Saffron Hill, London, E.C.1

(Illustrated below)

Aircraft Marine Products (GB) Ltd have announced the introduction in Europe of their range of crimpable plugs



and sockets. The housings are manufactured from either phenolic or diallyl phthalate and are available in 14, 20, 21, 26, 34, 41, 50, 75 and 104 positions. The contacts have a gold over nickel finish and are designed for crimping either with an automatic machine or a hand tool. When the automatic machine is used application rates of over 1 000 per hour can be achieved. After crimping, the contact is 'snapped in' to the mouldings. The contacts are easily inserted and extracted, which are invaluable features on prototype equipment.

EE 36 759 *for further details*

MAGNETIC MATERIALS

Standard Telephones & Cables Ltd, Connaught House, Aldwych, London, W.C.2

The STC range of 'Stanferite' magnetic materials has now been expanded and recoded. Details of the manganese-zinc, nickel-zinc and mixed ferrites in the range are given below.

Stanferite SA400 is a medium permeability manganese-zinc ferrite material having low losses and a low temperature coefficient of permeability. This material is suitable for high-grade stable inductors, pulse transformers etc, and can be used in tuned applications up to

approximately 1Mc/s. Higher frequencies may be used in certain non-tuned applications.

Stanferite SA600 is a high permeability manganese-zinc ferrite material having low losses and low temperature coefficient of permeability. It is suitable for wide-band transformers, low and audio frequency stable inductors, hybrid transformers, recording heads etc, and can be used in tuned applications up to approximately 500kc/s. Higher frequencies may be used in certain non-tuned applications.

Stanferites SB300, SB400, SB500, SB600 and SB700 are nickel-zinc ferrites of lower permeability, low dielectric constant and very high resistivity, suitable for transformers and similar applications. The permeability and frequency range for the respective types are as follows:

Type	Initial Permeability (Nominal)	Frequency Range
SB300	15	10Mc/s to 150Mc/s.
SB400	30	1Mc/s to 50Mc/s.
SB500	100	500kc/s to 15Mc/s.
SB600	200	200kc/s to 5Mc/s.
SB700	650	50kc/s to 2Mc/s.

Stanferites SC300 and SC500 are mixed ferrites having rectangular hysteresis loops and rapid switching characteristics for use in data storage and computer applications.

SC300 is suitable for storage or switching and is usually supplied in the form of micro-toroids but can be supplied in toroids up to a maximum dimension of 0·47in.

SC500 is suitable for coincident current memory matrices. It is usually supplied in the form of micro-toroids, but can be supplied in toroids up to a maximum dimension of 0·47in.

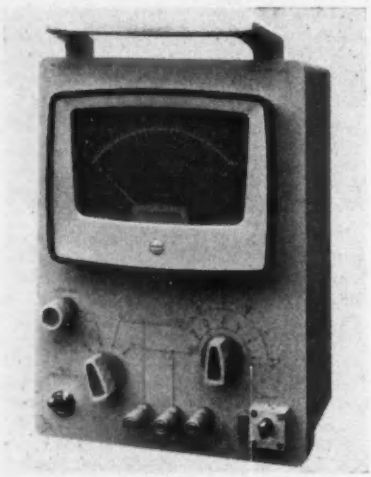
EE 36 760 *for further details*

FREQUENCY—CAPACITANCE METER

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Illustrated below)

This portable, battery powered frequency-capacitance meter type MM 1009



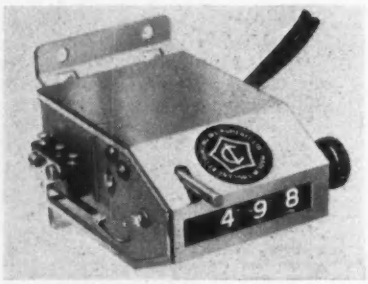
gives direct readings of frequency (0 to 100c/s to 0 to 100kc/s) and capacitance (0 to 1 000pF to 0 to 0·3μF).

As a frequency meter it has a ±3 per cent measuring accuracy on 5 ranges up to 10kc/s and ±5 per cent on the two ranges above. These accuracies hold for a 2 : 1 spread in mark-to-space ratio. The input signal (100mV to 150V r.m.s. amplitude) is limited and fed into a pulse counting type integrator circuit. With a suitable input transducer this direct reading frequency meter could be adapted for various applications in tachometry.

As a capacitance meter the MM 1009 covers the range 0 to 0·3μF in six ranges with a ±2·5 per cent accuracy maintained over the battery range 12V to 8V. The unknown capacitor is compared with the internal standard by substitution in the integrator circuit. Suitably chosen standards thus provide accurate direct readings of capacitance. The range is easily extended to 1·0μF.

Semiconductor devices are used throughout and it is powered by eight leakproof U2 cells (International Standard) or equivalent, giving a useful operating life of three months.

EE 36 761 *for further details*



ELECTROMAGNETIC COUNTER

Counting Instruments Ltd, 5 Elstree Way, Boreham Wood, Hertfordshire

(Illustrated above)

This new light-weight counter type 1250 is a three figure model with manual preset which enables the counter to be set to a predetermined number and when pulsed subtracts to zero when a microswitch either opens or closes a circuit.

The cut-out device is so arranged that the unit can be preset at any number between zero and 999.

Models are available for most standard voltages from 24V d.c. to 230V a.c. and care in the design has been taken to ensure that the unit is unaffected by humid conditions.

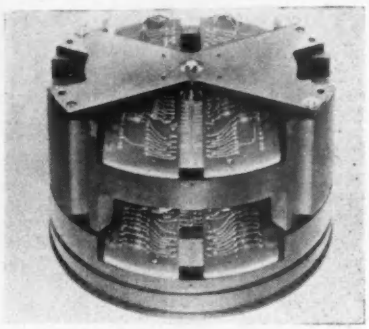
EE 36 762 *for further details*

SHAFT POSITION ENCODERS

Ketay Ltd, Eddes House, Eastern Avenue West, Romford, Essex

(Illustrated above right)

Recently introduced by the Norden Division of United Aircraft Corporation and now available in the U.K. through Ketay Limited is a new range of shaft position encoders.



Applications for these devices embrace machine tool control, film readers, and all types of navigation device, including those for the measurement of such variables as heading, bearing and azimuth.

Type ADC—36BCD provides 360 discrete counts per rotation of the input shaft, numerical indication of shaft position being given in degrees in binary coded decimal notation. Self-selecting V-brush logic is incorporated, so obviating the need for extensive external brush selection logic circuits. The encoder is contained in a size 33 standard U.S. Bu-Ord synchro mount through the use of the split-bit technique.

Type ADC—5-BCD (1000) is capable of 100 000 counts in only 100 turns of the input shaft. Like the previous type, this uses a self-selecting V-brush logic and the split-bit technique again permits incorporation of this high-resolution encoder into the smallest container possible. It is basically a 1 000 count per turn device.

The third type, providing 1 024 counts per shaft rotation, is contained in a standard U.S. Bu-Ord size 22 synchro mount and gives an output in Gray code. This device supplements the Ketay range of Gray code encoders which includes a size 18 providing 256 counts and a size 23 providing 512 counts per turn.

EE 36 763 *for further details*

CRYSTAL OVEN

Marconi's Wireless Telegraph Co. Ltd, Chelmsford, Essex

(Illustrated on page 535)

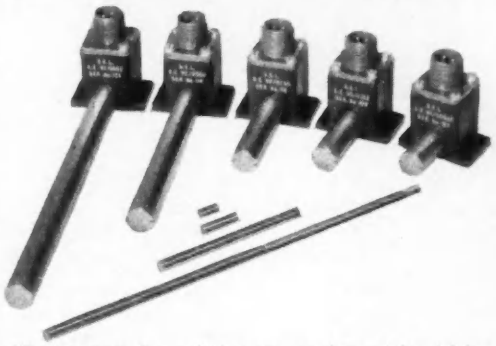
This oven has a cyclic temperature variation of only ±·0014°C, a figure which is achieved by making use of the property whereby a given substance (in this case naphthalene) changes from the solid state to the liquid at a temperature which is a constant for that substance.

The practical advantage of this method over conventional thermostats is that the oven gives a considerable increase in improvement factor. (The improvement factor is the ratio of change in outside temperature to that occurring within the oven.) In the case of the F3006 this is 250 : 1 or better—that is a temperature change of 25°C outside the oven would produce a change of only 0·1°C inside.

To measure pressure, displacement, acceleration.....

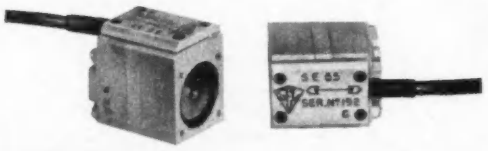
The range of inductive transducers from S.E. Laboratories provides sensitive and accurate units for converting from mechanical to electrical terms. With their high linearity and stability, coupled with a large electrical output to mechanical input signal, these SEL transducers offer a measuring device second to none.

DISPLACEMENT TRANSDUCERS



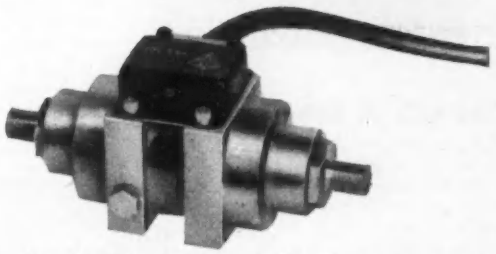
SE 92 and 95 *linear displacement transducers giving infinite resolution over ranges from* 0-±0.005″ *up to* 0-±1″.

ACCELEROMETERS

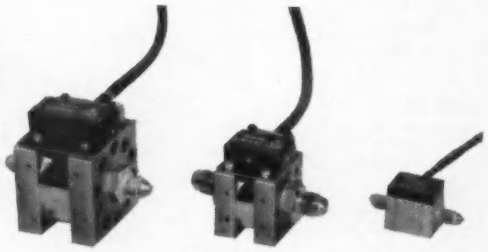


SE 55 *units with a high natural frequency covering acceleration ranges from* 0-±2G *up to* 0-±100G, *with excellent linearity, and insensitivity to cross-acceleration.*

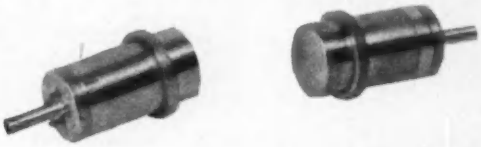
PRESSURE TRANSDUCERS



SE 50C *suitable for absolute and differential pressure measurements of corrosive liquids, in pressure ranges from* 0-5 *up to* 0-2,000 *p.s.i.*



SE 165, 150 and 70 *standard and miniature devices for absolute and differential pressure measurement in pressure ranges from* 0-10 *in. W.G. up to* 0-6,000 *p.s.i.*



SE 75 *a miniature high-temperature flush mounting pressure device requiring no pipework. Pressure ranges from* 0-2 *up to* 0-2,000 *p.s.i. Ideally suited for standard pressure scanning switches.*

For full details of these and other S.E.L. products—control and venting valves, frequency/DC converters, flowmeters, demodulators, carrier amplifiers, U.V. recorders, etc., contact:

S.E. LABORATORIES (ENGINEERING) LTD

North Feltham Trading Estate, Feltham, Middlesex. Telephone : Feltham 5876

EE 36 112 *for further details*

DESIGNING A DATA RECORDING SYSTEM

START HERE ▶

In the last analysis, the efficiency of a computer is closely linked with the characteristics of the magnetic tape you use to feed in information or record data. For example: in one application resistance to wear may be of paramount importance; in another the maximum amount of information must be recorded in a limited space.

Whatever your requirements, however, one of the many SCOTCH Brand Tapes for Computer and Instrumentation use will almost certainly meet them. These Tapes are *not* merely selected audio range tapes. Each is specially formulated to a different set of characteristics. Specifications are rigid and over 100 quality control tests during manufacture keep the tape up to standard.

For the widest range of characteristics and the highest standard of quality, specify SCOTCH Brand Magnetic Tape.

Scotch Brand Tape Advisory Service

We welcome enquiries, and the resources of our organisation, the largest manufacturers of magnetic tape in the world, are unreservedly at your disposal. But to make the best use of our unrivalled tape 'know-how', do, please, approach us as early as possible.

TRADE MARK

MAGNETIC

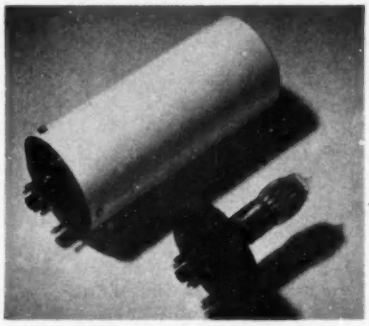
SCOTCH TAPE

BRAND

FOR COMPUTERS AND INSTRUMENTATION

ANOTHER 3M PRODUCT

MINNESOTA MINING & MANUFACTURING CO. LTD. 3M HOUSE, WIGMORE STREET, LONDON. W.1.



The principle of operation depends on the fact that while the melting point of the naphthalene is always a constant, the volume of the substance increases in the transition from solid to liquid. This increase is used to control the applied heat, so that in practice the temperature is maintained at the melting point and therefore stable. In other words, unlike the conventional thermostat, the change-of-state method of control exhibits a negligible cyclic temperature variation above and below the required operating temperature as the cyclic variation occurs in the proportion of solid to liquid.

The operating temperature of the F3006 oven is 79·5°C, the time taken to come within 0·2°C of this being 35min. The switching cycle at 20°C is 20sec on, 80sec off. The heater power supply is 24 to 30V 50c/s with a peak consumption of 30W. An octal base fitting is used.

EE 36 764 *for further details*

SYNCHRO TRAINER

Pioneer Designs Ltd, 6 Hampton Court Parade, East Molesey, Surrey

(Illustrated below)

This 'synchro trainer', produced by the Servokits Division of Pioneer Designs Limited, represents an addition to existing aids to education and training in the fundamental principles automatic control.

Data transmission, synchronous links and simple computing problems may be illustrated using the synchro trainer, and the student can study the effects of interchanging the rotor and stator connexions of different types of synchros in a variety of arrangements.

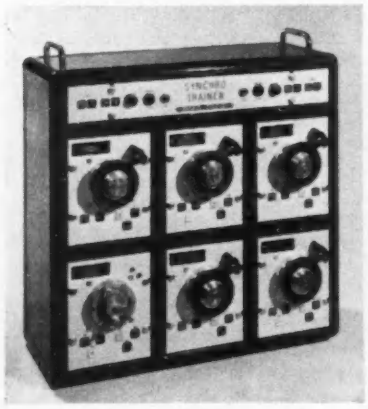
The equipment is entirely self-contained, having two internal 50V 50c/s supplies, separately fused, brought out to four pairs of sockets on a control panel from which random connexions may be made to the rotors and stators of six synchros fitted as independent units below.

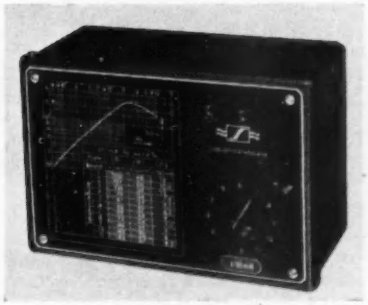
Each equipment is supplied with two control transmitters, one control transformer, one control differential transmitter, one resolver and one torque differential receiver. These are all standard admiralty pattern 3in 50c/s synchros and their rotor and stator connexions are brought out to sockets on the front panels of their individual units.

Interconnexions between power supply sockets on the control panel and synchro units are made with leads supplied fitted with 3mm plugs. With the exception of the torque synchro which has provision for attaching spring balances or weights for torque measurement, the remainder of the synchros are fitted with 3in diameter dials, and rotor locking devices.

Causes of simple faults can be demonstrated, and much of the ground-work for servomechanisms taught with a minimum of equipment and effort.

EE 36 765 *for further details*





INDUCTANCE DECADES

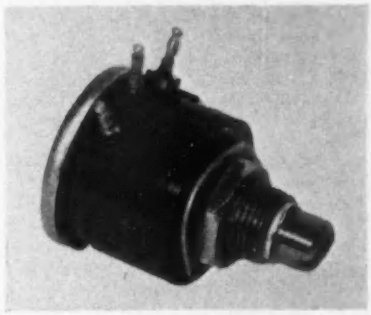
Distributed by: Wolsey Electronics Ltd, Cray Avenue, St. Mary Cray, Orpington, Kent

(Illustrated above)

These inductance decades are intended for quickly constructing filter circuits, electro-acoustic equivalent circuits, equalizers, experimental networks and the like in the audio-frequency range. By using large ferrite shell-type cores the quality factors (Q) for medium audio frequencies are maintained above 100 with good level stability and temperature independence. These quality factors (Q) are shown as a function of frequency on the front plate of each unit, the frequency coverage being from 50c/s to 10kc/s. An additional facility of all Grundig decades is the provision of plug and socket terminals fitted within the thumb terminal. This is extremely useful for demonstration work and for many research applications.

Models are available which cover the range of 1mH to 1·1H.

EE 36 766 *for further details*



MINIATURE WIREWOUND CONTROL

General Controls Ltd, 13-15 Bowlers Croft, Honywood Road, Basildon, Essex

(Illustrated above)

General Controls Limited announce that they are now producing a Miniature Wirewound Control that will dissipate 3W.

The size of this control is 0·916in in diameter by 0·660in deep, and it is fitted with a special silicone glass laminated former, a brass 'turned on' lid, and can either be supplied with turret lugs, solder tags, fly away connexions, or suitable for direct insertion into printed boards.

The housing is moulded in mica loaded material X4933/4, and can be supplied as a fully sealed tropicalized unit, with a maximum resistance value of 50kΩ.

EE 36 767 *for further details*

BLOOD CELL COUNTER

Coulter Electronics Ltd, 2-4 Ashwell Street, St. Albans, Hertfordshire

(Illustrated below)

The new Coulter counter, model 'D', is designed for the routine counting of blood cells in medical laboratories.

The new model is a similar and more compact version of the standard Coulter counter, utilizing the same basic system of passing a suspension of blood cells through a small orifice simultaneously with an electric current. The individual blood cells passing through the orifice introduce an impedance change in the orifice, and are counted at a rate in excess of 5 000 individual cells per second. The number of cells counted is approximately 100 times greater than the

usual microscope count to reduce the statistical error by a factor of approximately 10 and is completed in 20sec.

The high degree of accuracy and reproducibility of results obtained with the instrument is matched by the simplicity and speed of its operation. A beaker, containing a suitably diluted sample of blood, is placed on a spring platform so that the orifice tube is immersed in the sample. The count is automatically made by turning a stopcock and depressing the count switch. The count is displayed on a decade counter; in the case of red blood cells this is multiplied by 100 to give the number per cubic millimetre. The white cell count per cubic millimetre is the figure shown on the counter. After noting the count the beaker is removed and the next sample positioned on the stand. No rinsing or cleaning of the orifice tube is required between samples. The instrument is readily operated by a junior technician and as many as 60 samples per hour can be dealt with.

The complete instrument (except for a waste bottle) is contained in a single case measuring 13in by 15in and weighing 31 lb.

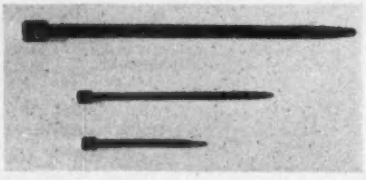
EE 36 768 *for further details*

CABLE TIES

Insuloid Manufacturing Co. Ltd, Sharston Works, Leestone Road, Wythenshawe, Manchester 22

(Illustrated below)

These 'Insulock' nylon cable ties are



as strong and lighter than metal straps and will withstand temperatures from −80°C to +150°C. They have a non-return cam locking device which prevents them from slackening or becoming detached.

Besides giving a neater, more compact, appearance, these ties also produce substantial savings in wiring costs. They resist chemical attack, and are suitable for use in all climatic conditions.

Three sizes are available, types LK.1, LK.2 and LK.3. These are suitable for binding groups of cables up to 9/16in, 1 1/16in and 2in diameters, respectively. For larger diameters, two or even three ties may be linked together.

EE 36 769 *for further details*

R.F. SPECTROMETER

Telefunken. GmbH, Berlin, Charlottenburg 1, Germany

(Illustrated above right)

The wideband r.f. spectrometer type SIG 488/1 is intended for the rapid spectral analysis of r.f. oscillations and is suitable for use in radio measuring stations, transmitter stations, laboratories etc for the determination of transmitter bandwidth and out-of-band radiation, the

measurement of crosstalk and modulation distortion etc.

The equipment operates on the heterodyne principle and both the analysing range (±25kc/s maximum) and the analysing speed (2 to 3sec) are continuously variable.

The amplitude measuring range covers 80dB and amplitude display is logarithmic. The spectrum is displayed on a long-persistence cathode-ray tube. For evaluation a calibrated flood-lit scale is provided whose calibration can be checked by means of an incorporated calibration mark generator and calibration divider. A camera accessory renders possible, in conjunction with an automatic camera, the photographic recording of the spectrum.

The spectrograph can be supplied for desk mounting or insertion in German Standard DIN or RETMA racks. In combination with an auxiliary signal generator it can be used for direct measurements in the frequency range between 40kc/s and 30Mc/s, or for telemetering (remote supervision) in conjunction with a receiver: in the latter case the frequency range is dependent on the receiving range of the receiver.

EE 36 770 *for further details*

DIRECT-WRITING RECORDERS

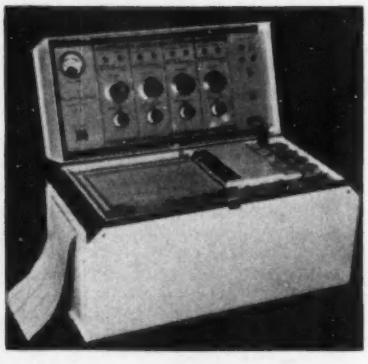
Distributed by: Leland Instruments Ltd, 145 Grosvenor Road, Westminster, London, S.W.1

(Illustrated below)

A new range of industrial direct-writing recorders manufactured by Officine Galileo of Florence is now available in the United Kingdom through Leland Instruments Ltd.

The recorders, employing ink pen or hot stylus, can be supplied in several standard models—portable single pen, two or four pen instruments or rack-mounted on wheels and having 2, 4, 6, 8, 16 or 32 channels, thus permitting the simultaneous recording of an equivalent number of phenomena.

The pre-amplifier units, containing



voltage amplifying stages, their controls and (if required) filters, incorporate printed circuits and transistors. They are sturdy and compact and may be inserted and removed quickly from the recording unit. A wide range of pre-amplifiers, suitable for any technical measurement, is available.

The hot stylus record has the advantage of being in cartesian co-ordinates permitting easy interpretation and correlation of multi-channel recording. For low speed phenomena this system affords high resolution and a well defined trace. The multi-channel instruments may have a built-in photographic recorder allowing the examination of phenomena whose higher frequency components (200-800c/s) would not be reproduced by direct-writing pens.

The Galileo recorders operate from a power supply of 110 to 220V, 50c/s, have a response time of 0·01sec and paper speeds varying from 2·5mm/sec to 100mm/sec. If required, other paper speeds and time-marker may be included.

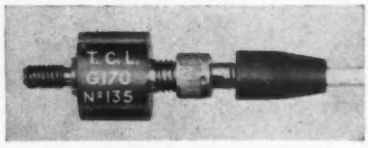
EE 36 771 *for further details*

ACCELEROMETER

Technical Ceramics Ltd, Wood Burcote Way, Towcester, Northamptonshire

(Illustrated below)

Technical Ceramics Limited, a member of The Plessey Group of Companies has introdupced a new accelerometer, type G 170, for vibration tests in a wide range of applications. Particular uses



of this accelerometer are in the aircraft and automotive industries and in the development of shockproof packaging techniques. A special feature is its light weight of 5g which enables it to be used for testing component parts as well as complete assemblies. It is ¼in long and ¼in diameter, and is fitted with a sub-miniature coaxial connector. The G 170 will operate over a frequency range from 5c/s to 3·5kc/s, and will measure shock and vibration in the range 0·1 to 400*g*. Operating temperature is −40°C to +80°C and the units are fully sealed to withstand conditions of high humidity.

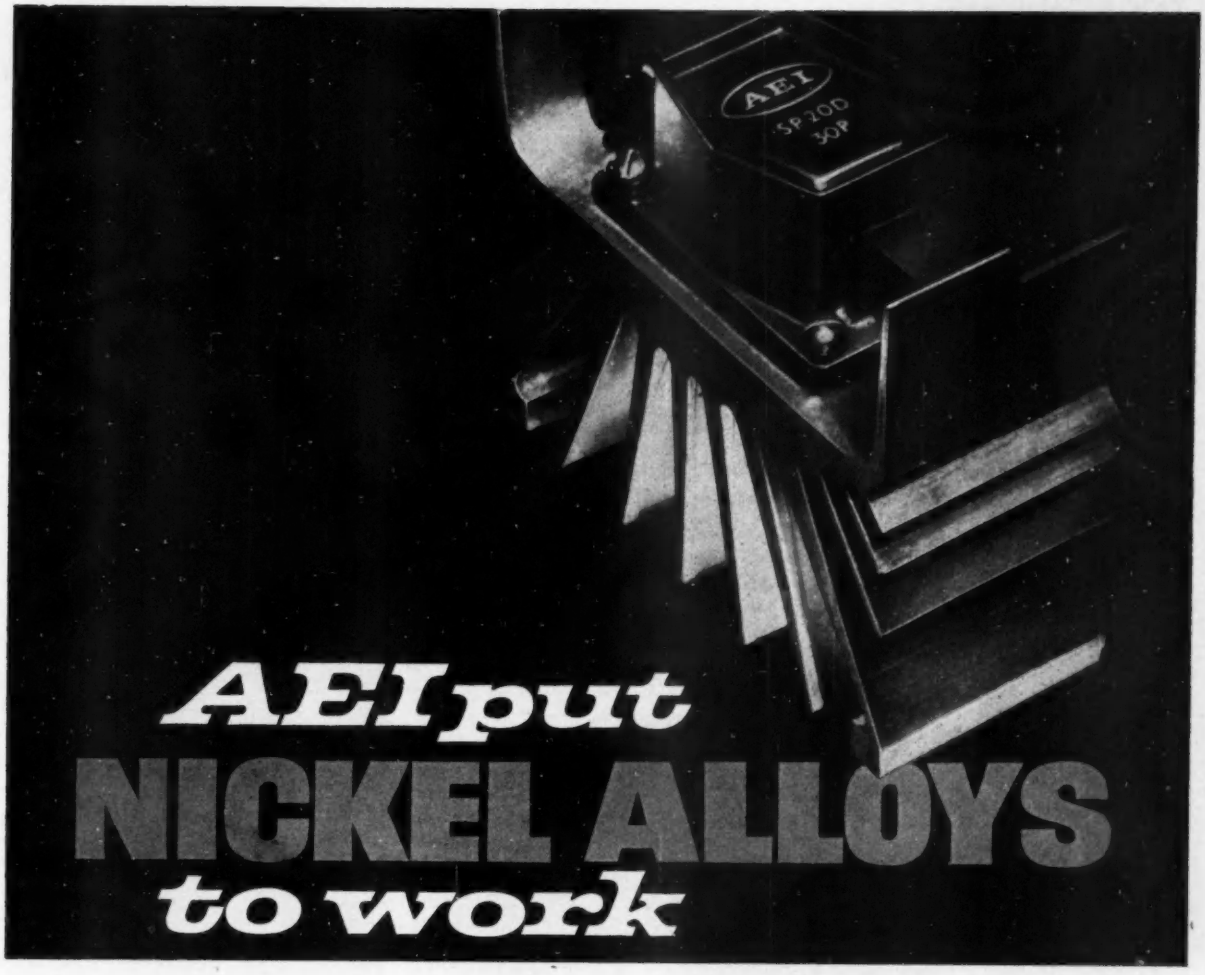
The accelerometer uses a bender-type transducer to give maximum sensitivity in a coaxial direction with minimum sensitivity in other directions. A high self-capacitance has been achieved, which enables measurement to be made at low frequencies using a cathode-follower unit.

EE 36 772 *for further details*

TRANSISTOR CLIPS

Jermyn Industries, 74 Lakeside Drive, Bromley, Kent

The 'Sistaclip' is suitable for transistors of diameters from 0·189in to



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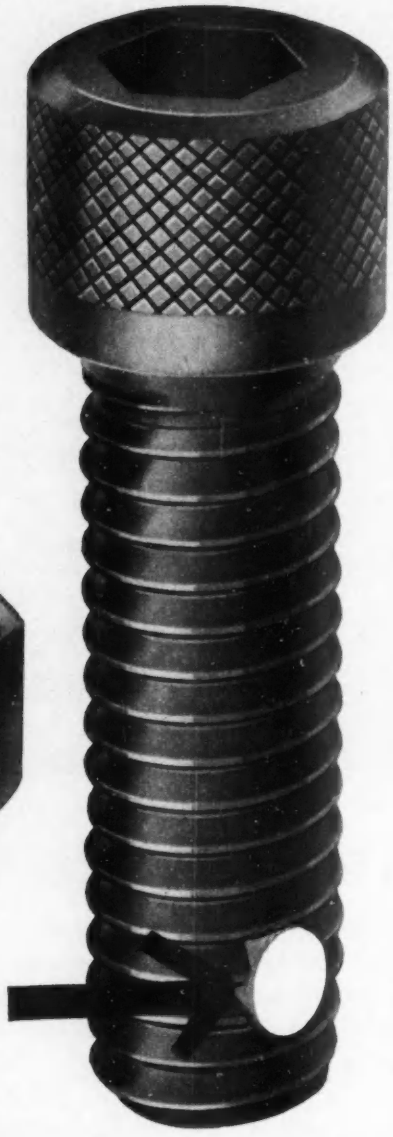

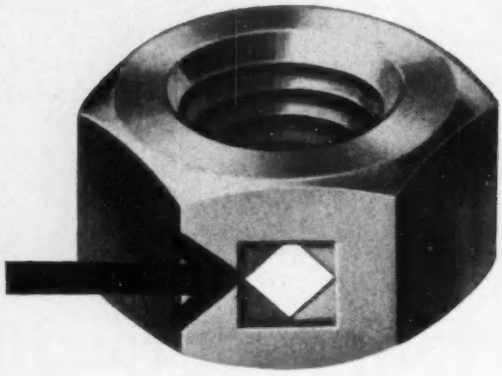

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S/WK/3827

0·250in which includes all transistors from the OC44 to the BCZ11. The clip is made of beryllium copper 0·006in thick and is usually silver plated. Its chief assets are that it occupies very little space and that the transistor is very easily inserted and removed.

Also available is a clip suitable for both the OC170 and the Jedec T05 case size. This transistor clip is also made of beryllium copper and will accommodate diameters from 0·305 to 0·358in.

For the same size transistor a plastic holder in nylon or p.t.f.e. is being developed. This will permit the mounting of this transistor size direct to printed circuits or chassis. This latter application brings into line the mounting of transistors with the current tendency towards direct chassis mounting of components on feed-through insulators etc.

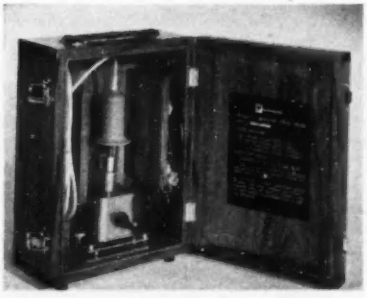
EE 36 773 *for further details*

PULSE MEASURING POTENTIOMETER

Ferranti Ltd, Hollinwood, Lancashire

(Illustrated below)

For the accurate measuring of high voltage pulses in radar transmitters and



other pulse circuits, Ferranti Ltd have introduced the type PD.30 pulse measuring potentiometer.

The potentiometer can either be built into an equipment to provide a permanent pulse voltage measuring facility, or can be supplied in a case as a portable test instrument for use in the laboratory. This small lightweight instrument consists of a high voltage vacuum capacitor internally shielded by a metal cylinder to eliminate the effects of external stray capacitances, and a lower element which is either a capacitor for high voltage division or a resistor for differentiation. The lower elements are protected by a Ferranti type AD.42 cold-cathode diode.

The PD.30 is designed for handling high voltage pulses up to 30kV and has four ranges provided by a selector switch giving two pre-set voltage division ratios and two differentiation ratios. Voltage division ratios are normally pre-set for ratios of 250 : 1 and 500 : 1 and differentiation ratios are pre-set for 7·5kV/μsec/V and 5kV/μsec/V. Input capacitance of the measuring oscilloscope has some effect on the calibration, and an allowance of 45pF has been made. On the most sensitive 250 : 1 range a change of 8·5pF produces approximately a 1 per cent error. The top capacitance of the device is 3·4 ±0·2pF and the total load capacitance is 6pF maximum.

The instrument is supplied complete with convenient connecting leads for both the high voltage and oscilloscope connexions. Shunting effect of connecting cable capacitance on the resistive element is minimized by inserting the lead through plug/socket, which is provided, and has selected terminating resistors incorporated. The high voltage lead is fitted with a clip which enables the potentiometer to be easily connected across the high voltage pulse circuit being measured, i.e. across the magnetron pulse transformer.

The oscilloscope being used must have a high impedance input for all ranges.

EE 36 774 *for further details*

RATIO TRANSFORMERS

Wayne Kerr Laboratories Ltd, 44 Coombe Lane, New Malden, Surrey

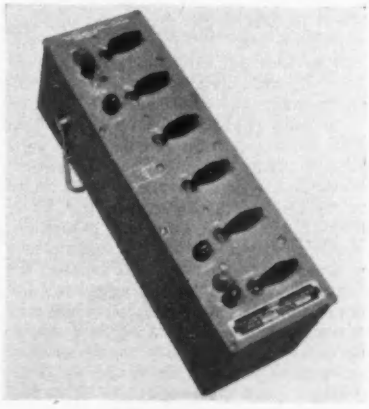
(Illustrated below)

These Wayne Kerr-Gertsch ratio transformers provide an accurate means of providing and measuring a.c. voltage ratios over a wide frequency-range. Typical applications of these transformers are as ratio standards, in, for example, the ratio arm of a bridge, or as an a.c. potentiometer for checking resolvers, servos, transformers and computers.

Known as the RT4 and RT5, the new transformers operate from 30c/s to 1kc/s and 50c/s to 10kc/s respectively and have a high input impedance, low effective series impedance and extremely low-phase shift. Over the lower frequency range, ratio accuracies of 0·001 per cent are obtainable; 0·01 per cent accuracy is obtainable over the higher range.

Ratios are selected by operating five decade switches and a single-revolution potentiometer. This arrangement provides continuous resolution and read-out of better than six significant figures, each ratio value being shown as a direct decimal reading.

Both units have a terminal linearity of 0·001 per cent and a very small phase-angle under loaded conditions—the actual size of the angle depending on the frequency and ratio settings.



Effective series impedance of the RT4 is 4Ω and its input inductance 500H; comparable figures for the RT5 are 3Ω and 150H. Normal temperature range for both transformers is from −15°C to +80°C.

Each unit is available either in a cast aluminium case or rack mounted with an aluminium dust cover.

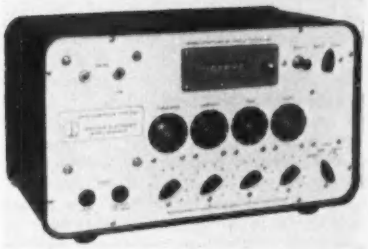
EE 36 775 *for further details*

BATCH COUNTER

Thorn Electrical Industries Ltd, Thorn House, Upper Street, St. Martin's Lane, London, W.C.2

(Illustrated below)

The CB.11 is a compact versatile electronic batch counter with a counting speed up to 4 000 per second and a batching rate of one per second. It is intended for use in applications where a high production rate of articles is being achieved such as tablets or pills which are being produced in quantity and automatically packed into boxes. The unit is capable of counting 10 000 items in one batch and up to 1 000 000 batches without re-setting.



The batch size may be quickly and easily set by means of selectors on the front panel. A total count of 10 000 000 000 may also be achieved by using the two counters in series.

EE 36 776 *for further details*

MESA TRANSISTORS

Texas Instruments Ltd, Manton Lane, Bedford

Texas Instruments have extended their range of transistors with the announcement of three new germanium alloy-diffused Mesa transistors, specially designed for operation in high frequency amplifiers and fast switching circuits.

Each device type is characterized to facilitate circuit design covering the following applications:

2G401—High gain i.f. amplifier at 465kc/s and 10Mc/s.
2G402—V.H.F. amplifier at 100Mc/s.
2G403—Logic and arithmetic circuits operating at clock rates of 10Mc/s.

To ensure high reliability under extreme environmental conditions these transistors are hermetically enclosed in an all-welded JEDEC TO-5 package. Wide lead spacing permits automatic insertion on printed boards in production equipment.

The alloy diffused Mesa technique ensures low leakage currents, improved high frequency operation, good bottoming characteristics and increased power dissipation.

EE 36 777 *for further details*

Short News Items

An International Congress of Automation under the patronage of the Associazione Italiana Nazionale per L'automazione 'A.N.I.P.L.A.' and the auspices of the Italia '61' Committee will be held in Turin from 24 to 26 September 1961 at the Headquarters of the Polytechnic, as part of the Programme of events to celebrate the first one hundred years of Italian Unity. The second congress of the International Federation of Automatic Control (IFAC), will be held in Basle, Switzerland, in September 1963, at the invitation of the Swiss Association for Automatic Control. A committee of the British Conference of Automation and Computation will co-ordinate the submission of papers from the United Kingdom to the congress. Most of the papers will deal with the theory or application of automatic control; a number will also deal with the components of control devices. Papers may be submitted in English, Russian, French or German. The final version of any paper by a United Kingdom author should be in the hands of the BCAC committee not later than 1 June 1962 for transmission to the International Selection Committee of IFAC during August, 1962. The Executive Council of IFAC have ruled that the number of papers shall not exceed 100. Offers of papers from the United Kingdom should be made to the Honorary Secretary, BCAC, c/o The Institution of Electrical Engineers, Savoy Place, W.C.2. General inquiries concerning the congress arrangements should be made to the Secretary of IFAC, Dr.-Ing. G. Ruppel, Prinz-Georg-Strasse 79, Dusseldorf, Germany.

The Midland Bank Ltd has placed an order with The English Electric Co. Ltd for a KDP 10 electronic computer system, which will service all the current accounts —amounting to well over 100 000—of 60 branches in the London area. The English Electric computer, which will cost about £250 000 will be operational during the autumn of next year. The basic principle of the system is the maintenance of all the branch current account records centrally on magnetic tape, and ledger posting from the tape files according to the information fed in daily from the branches. The intention is to set up a computer centre in the West End of London, and to equip each of the 60 Midland branches with accounting machines fitted with special attachments to produce punched paper tape. The paper tapes carry all branch data for feeding into the central computer and this is done at the rate of some 1 000 characters a second—equivalent to about 40 cheques or credit vouchers every second. Coupled to high speed printers producing print at 600/900 lines a minute, the computer will sort and "post" in only 4½ hours the information fed in from the 60 branches. Customers' statements and copies for the Bank's records will be produced in one operation. The Bank estimates that a staff of from 10-12 will be required at the computer centre to control the work of the system.

Electronic Associates Ltd, a British subsidiary of the American company which manufactures PACE analogue computing equipment, have recently completed their first British-made version of a precision analogue computing system. They have also recently opened an analogue computing centre at Burgess Hill, Sussex, where both machines and engineers can be had on a time-hire basis.

Vactric Control Equipment Ltd have changed their address from Vactric House, Sloane Street, S.W.1, to 30 Bouverie Street, London, E.C.4. The new telephone number is Ludgate Circus 7061.

The British Broadcasting Corporation has awarded a contract to Pye Telecommunications Limited of Cambridge for the supply of four microwave links. The Pye links will operate in the 7Gc/s band and each will consist of a transmitting terminal, with two transmitters, and a receiving terminal, with two receivers. Automatic changeover facilities will be provided. The equipment will be used to convey programmes to certain new low-power satellite television stations which are being set up to extend the coverage of the BBC's Television Service. Pye Telecommunications Limited are supplying also to the BBC a duplicated microwave transmitting terminal for installation at their North Hessary Tor station.

An International Television Conference, covering all scientific and engineering aspects, is being organized by the Electronics and Communications Section of the Institution of Electrical Engineers. It will be held in the Institution building in London from 31 May to 7 June 1962. This period will overlap the last three days of the International Instruments, Electronics and Automation Exhibition being held at Olympia, London, at that time, at which most British and many oversea manufacturers of professional television equipment and apparatus will be exhibiting. Arrangements are being made for linkage with this exhibition, and it is expected that the coincidence of these two attractions will increase the number of electronic engineers and technologists from abroad, who will take the opportunity of attending both events. An organizing Committee has been set up under the Chairmanship of Dr. R. C. G. Williams, and includes P. A. T. Bevan, C.B.E., Captain C. F. Booth, C.B.E., Dr. J. S. McPetrie, C.B., Commander C. G. Mayer, O.B.E., M. J. L. Pulling, C.B.E., Dr. R. L. Smith-Rose, C.B.E., Dr. J. A. Saxton, R. C. Winton and A. J. Young, C.B.E. The submission of papers is invited and further information may be obtained from the Secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

The BBC has placed a contract with J. L. Eve Construction Co. Ltd for the supply and erection of a 750ft mast to carry the aerials of the new South-East Scotland television and v.h.f. sound station which is to be built at Dryden Hill, midway between Selkirk and Hawick. This is one of several stations which the BBC is building to extend and improve the coverage of its television and v.h.f. sound services. The South-East Scotland station will serve an area including Galashiels, Lauder, Duns, Selkirk, Hawick, Jedburgh and Coldstream, with a population of nearly 100 000 people, some 70 000 of whom have not hitherto been within range of the BBC television or v.h.f. sound services. It is expected that the station will be completed by the autumn of 1962.

Multimusic Limited, a wholly-owned subsidiary of Multicore Solders Limited, announces that it has disposed of all its interests in Reflectograph Tape Recorders to Pamphonic Reproducers Limited, a Pye Group Company. Pamphonic are now responsible for all service of Reflectograph recorders and service enquiries should be addressed to Pamphonic Reproducers Limited, Westmoreland Road, Queensbury, London, N.W.9. Telephone COLindale 7131.

Imperfections in Crystals is the title of the Autumn Conference of the X-Ray Analysis Group of the Institute of Physics and the Physical Society. The Conference will be held on 17 and 18 November at the Institution of Mechanical Engineers in London. The three sessions of the conference will be devoted to the nature of crystal imperfections and of associated diffraction effects, to experimental methods for studying imperfections, and to their influence on the physical properties of crystals. Included in the invited speakers will be Dr. P. B. Hirsch, F.Inst.P., of the University of Cambridge, and Professor F. C. Frank, O.B.E., F.Inst.P., F.R.S., of the University of Bristol. Correspondence regarding the programme should be addressed to the Honorary Conference Secretary, Dr. G. S. Parry, A.Inst.P., Department of Chemical Engineering, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7. Enquiries re-

garding attendance should be addressed to the Administration Assistant, The Institute of Physics and The Physical Society, 47 Belgrave Square, London, S.W.1.

Senior Staff Consultants Limited announce that they have formed a special department to deal exclusively with the recruitment and appointment of staff for all aspects of computer work. To assist them in this project they have retained the services of Computer Consultants Limited and have taken over the specialist staff appointment service previously run by this company.

IBM (United Kingdom) Ltd are to provide for the Scottish Co-operative Wholesale Society Ltd what will be the largest electronic computing system installed in Scotland. The computer will control warehouse stocks, correlate statistical information, prepare sales invoices and carry out a wide range of ancillary functions. The computer will be an IBM 1401 using magnetic tapes and RAMAC magnetic disk storage and will be installed in 1963. It will be some five to six years before the re-organization is complete and the machine geared to its maximum usefulness. First duties will be in the SCWS grocery warehouse and from there it will be extended to other sections of the undertaking. The machine will record the original order, check for stock availability, prepare requisition notes allowing release of the goods, provide a sales invoice and maintain the sales ledger. When not employed on this work it will provide statistical information on a wide range of functions.

Decca windfinding radar has been ordered by the Government of Indonesia for use by their Meteorological Department in Djakarta. The equipment being supplied is the type WF 2, a new and higher performance version of the original Decca primary radar windfinding system. The installation of this radar in Indonesia will be the first step towards the establishment of a chain of upper air windfinding stations to supply accurate and regular wind information to heights 100 000ft and above over the whole area, for aviation, defence and general meteorological purposes. Britain is the prime supplier of specialized radar to meet the upper air windfinding requirement, and Decca state that over 40 world meteorological authorities are now using their equipment.

Home and export sales of electronic capital goods last year were worth more than £57M—some £4·5M up on 1959. Exports, at £29M, showed an increase of £4 384 000 over 1959, and accounted for more than half the total sales. In the four years 1957 to 1960 sales of British electronic capital goods have risen by more than a third and exports have increased by nearly a half. The rising sales of electronic computers—worth more than £8M last year—reflect their growing and widespread use. Since 1957 the electronic computer industry has more than doubled its total sales and almost trebled its exports, which last year were worth £2 301 000.

The Amalgamated Engineering Union has placed an order with International Computers and Tabulators Limited for an I.C.T. Type 555 electronic computer and ancillary equipment to the value of £67 000. The A.E.U. with over a million members in 2 400 branches is one of the biggest unions in the country and is the first to adopt this form of mechanization for the benefit of its members. The I.C.T. equipment will be used for the centralization of accounting for members' contributions and for issuing quarterly members' statements. Sickness and death benefits and other payments are planned to come within the scope of the computer.

Thorn Electrical Industries Limited and Associated Electrical Industries Limited announce that they are merging their respective interests in the manufacture and sale of cathode-ray tubes and radio valves. For this purpose the productive capacity of both companies in this field will be pooled and will include factories at Sunderland, Harlow, Rochester and Footscray. Well-known trade marks involved include Mazda, Ediswan and Brimar. Associated Electrical Industries Limited and Thorn Electrical Industries Limited will both be represented on the Board and will have equal shareholdings in the joint company. Management will be vested in Thorn Electrical Industries Limited with Mr. Jules Thorn as Chairman.

Coutts Bank Ltd, at Cadogan Place, S.W.1, is now equipped with an EMI Electronics Ltd closed-circuit television system, which enables customers and staff to inspect ledger sheets immediately, without waiting for them to be sent down from the accounts department. In this way, although the whole of the ground floor space is devoted to banking activities, the staff has the same advantages as if the accounts department were in the same room. An operator in the ledger room places the required ledger sheet in a document scanner equipped with the latest type EMI closed-circuit television camera. Television receivers in the manager's office, the waiting room and the general office are mounted on turntables so that they can be swung around for viewing by different people. Quick contact can be made among the staff by means of a telephone system between each receiver and the ledger room. A similar television system at Coutts' new branch in Lombard Street has been in operation for three months.

A colour television refresher course is being organized by The Television Society. The course of six lectures will cover a description of the NTSC system, transmission problems and receiver problems. The lecturers will be Mr. S. N. Watson, BBC Designs Department, and Mr. G. B. Townsend and Mr. P. Carnt of the G.E.C. Hirst Research Centre. The lectures will be given on six consecutive Monday evenings between 18 September and 23 October in the large lecture theatre of the London School of Hygiene and Tropical Medicine. Enrolment forms are available from The Television Society, 166 Shaftesbury Avenue, London, W.C.2.

Noise Measurement is the subject of a five-day course commencing on 11 September at the Royal College of Advanced Technology, Salford. The course is designed to meet the needs of those already involved in noise measurement but requiring further tuition and to cater for others about to face the problems of assessing and reducing noise. The accent will be placed on practical measurement and the familiarizing of the student with typical instruments. The supporting lectures will contain only a minimum of physics and mathematics necessary to follow the course. A number of experts are devoting considerable time to assisting both with the lectures and in supervision of practical classes. Further details can be obtained from Dr. P. Lord, Royal Technical College, Salford, 5, Lancashire.

International Systems Control Ltd is a new company which has been formed jointly by The General Electric Co. Ltd, of England, and Thompson Ramo Wooldridge Inc (TRW), of Los Angeles, U.S.A. The object of the new company, which will have its headquarters in London, is to market industrial process control systems in Great Britain, the European Free Trade Area and the Commonwealth. TRW's contribution is to provide specialized knowledge of process control systems including computer designs and G.E.C. is making available relevant patents, key personnel and in particular its advanced electronic engineering resources, and its experience and extensive facilities for the manufacture of precision electronic equipment. International Systems Control Ltd., will apply the knowledge and experience of both partners in designing the control system for each process.

The BBC announces the appointment of Mr. G. D. Monteath, B.Sc., A.R.C.S., A.Inst.P., A.M.I.E.E., D.I.C., as Head of Television Group, Research Department, in succession to Dr. R. D. A. Maurice, Ing.-Dr., Ing.E.S.E., A.M.I.E.E., who recently became Assistant Head of Research Department. Mr. Monteath joined the BBC as a research engineer in 1947. He was appointed Head of the Aerial Section of Research Department in 1953 and became Assistant Head of the Television Group in 1958.

4 200 hours of continuous operation without a failure of any sort has recently been completed by an Elliott 803 computer which is part of a Panellit 609 in-

formation and computing system in use at Gulf States Utilities Power Station, Louisiana. Both Elliott Brothers (London) Limited, who made the computer, and Panellit Limited, who designed and supplied the Panellit 609 System are members of the Elliott-Automation Group.

The London Minicab Scheme, which is operated by Welbeck Motors Ltd, will form, according to Pye Telecommunications Ltd, the largest radiotelephone system in Europe. The installation which recently opened with 200 radio-taxis is expected to expand to 800 by the end of the year. The system has been planned with six-channel radiotelephone equipment which is installed under the dashboard of each car and will give communication over a radius of 20 to 25 miles of Piccadilly Circus. A special control room, where 20 G.P.O. telephone lines have been installed initially, has been engineered and a conveyor-belt message system is designed to handle calls at the rate of one every two seconds.

The Fédération Nationale Des Industries Électroniques (F.N.I.E.) announce that the National Exhibition of Radio and Television will be held from 14 to 25 September 1961 and that the International Exhibition of Electronic Components will be held from 16 to 20 February 1962. Both exhibitions will be held in the Parc des Expositions in Paris.

The Council of the Scientific Instrument Manufacturers' Association of Great Britain, 20 Queen Anne Street, W.1, states that its 19 members who took part in the combined stand at the recent British Industries Fair at Moscow are very well pleased with the results. Firm contracts have been signed for 75 per cent of the quarter of a million pounds worth of their exhibits. Preliminary contracts for a considerable additional quantity of equipment to be exported immediately or in the near future have also been placed. Although the Russian trading organizations were very busy, hard pressed, and drove hard bargains, they were also most co-operative and displayed a friendly spirit which was much appreciated by the S.I.M.A. members.

The McMurdo Instrument Co. Ltd announce that as an aid to quicker delivery of small orders for Ministry Released valveholders they have made arrangements with Stewart Aeronautical Supply Co. to act as stockists for the most commonly used types. The prices from Stewart Aeronautical will be identical with those obtained directly from McMurdo and customers will find it beneficial to place orders for 500 or less Type Approved valveholders directly with Stewart Aeronautical Supply Co. Ltd, Adastral House, Nutfield, Redhill, Surrey (telephone Redhill 5050).

The Dieppe Lifeboat Committee has been presented with a Pye International marine radiotelephone by the French National Railway. This is the first French National Lifeboat to be equipped with v.h.f. radio. It will work into the Dieppe Railway Radio Station and the local Public Correspondence Scheme. The Lifeboat will thus be able to communicate with cross-channel steamers, with local fishing boats which have the requisite equipment and with the Boulogne Sur Mer Radio Station. A Pye engineer has been over to Dieppe to install the radiotelephone in the Lifeboat—the S.S. Brighton.

A Symposium on Electromagnetic Theory and Antennas is to be held at the Technical University of Denmark, Copenhagen, on 25 to 30 June 1962 and papers are invited on the following subjects:

Electromagnetic fields in anisotropic media, such as plasmas and ferrites.
Diffraction theory.
Scattering in random media.
Quasi-static electromagnetic problems.
Theory of broad-band antennas.
Antenna pattern synthesis.

Summaries of between 80-1 200 words should be sent before 1 December 1961 to:

H. Lottrup Knudsen, Secretary, Symposium on Electromagnetic Theory and Antennas,
Oster Voldgade 10 G,
Copenhagen,
Denmark,

from whom full details of the Symposium can be obtained.

A Doppler radar navigation system is to be manufactured by Elliott Brothers (London) Ltd under licence from the Bendix Corporation of America. The equipment will be manufactured to the American specification and will be identical to that manufactured by Bendix but British components will be used so far as is possible. It is a four beam f.m./c.w. system operating on 880Mc/s and with the exception of the transmitter tube and its power supply it is completely transistorized.

The D.T.V. Group of Companies consisting of Beulah Electronics, Direct T.V. Replacements Ltd, and Direct T.V. Windings Ltd, will not now be joining the Derritron Electronic Group of Companies. The reasons for this merger not proceeding are purely technical, and the decision has been reached with regret on both sides. The two Groups will continue to co-operate in the future, and Derritron Limited have been granted the sole agency for the Beulah television camera in respect to the U.S.S.R. Chinese Republic and certain East European countries. Mr. A. Rose, M.I.R.E., will continue to be Managing Director of the D.T.V. Companies and the Registered and Sales Offices are at 138 Lewisham Way, New Cross, London, S.E.14. Telephone Tideway 6666.

A complete television broadcasting system of an entirely new design, costing a third of the price of existing comparable television stations has been announced by Pye T.V.T. Ltd. With studio, control room, telecine, transmitters, mast, aerial and all other equipment included as a 'package', the new system can be bought for £17 000. The 'Cambridge Station', as the equipment will be known, is a simple, economic television station with technical facilities specially developed to bring television to smaller communities which may initially be unable to support the cost of more complex installations. The studio contains two cameras, four microphones and an efficient lighting system. In the control room is a console with all monitoring and mixing facilities, two 16mm telecine units with slide projectors, two transcription/gramophone units, a monitor loudspeaker, two equipment cubicles and the vision and sound transmitters. An appropriate aerial system is mounted on a 100ft high mast erected immediately beside, or on top of, the station building. The range of the station will naturally vary according to geographical location—but in reasonably flat country good pictures should be received within a radius of up to 10 miles.

The 4th International Instruments, Electronics and Automation Exhibition to be held at Olympia, London, from 28 May until 2 June, 1962, will be even larger in area and in number of exhibiting firms than the record breaking show of 1960. Already 90 new firms, illustrating the continuing growth of the industry, have joined with regular exhibitors who have booked 90 per cent of the available stand space. Applications for stands totalling nearly 160 000ft² of exhibition space have been received from 400 firms from the United Kingdom and ten countries overseas, including France, Germany, Italy and U.S.A.

British Railway's north-eastern region is to be equipped with a super-high-frequency multi-channel radiotelephone system between York and Newcastle via Darlington—a distance of 78 miles. This will be the first multi-channel radio telephone and telegraph installation to be used by British Railways and, indeed, the first 'private' multi-channel service in Britain to operate on a frequency of 7500Mc/s. The radio equipment is to be supplied and installed by Marconi's Wireless Telegraph Co. Ltd, and the carrier equipment by Automatic Telephone and Electric Co. Ltd. The system is designed for a maximum capacity of 300 telephone channels, but initially 180 will be in operation. It will handle the telephone traffic between the regional centres, with full facilities for through subscriber trunk dialling; ultimately its use may be extended to provide facilities for high-speed data transmission—for example, it could be used as a means of centralizing account systems and for other matters of a similar nature.

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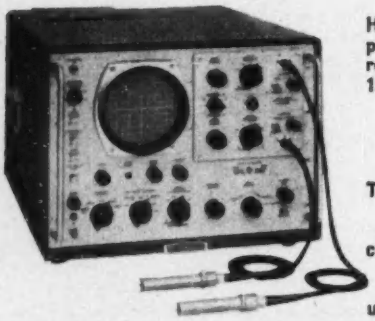
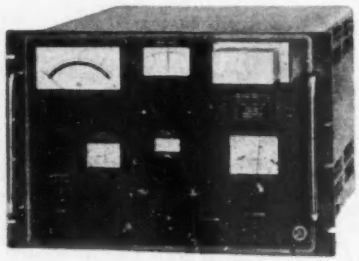
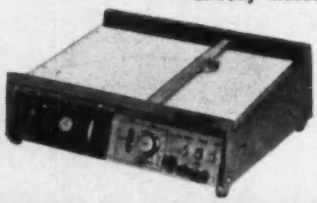


Hewlett-Packard Model 185 A Oscilloscope DC-1000 MC. Completely new circuit approach permits viewing — on a bright 5" cathode ray tube — of repetitive short pulses requiring a bandwidth up to 1000 MC. Rise time less than 0.45 nanoseconds. Sensitivity 10 mV/cm. to 200 mV/cm. Horizontal sweep times 0.1 to 100 nanoseconds/cm.

The new BRC UHF Q Meter Type 280-A is a unique self-contained instrument for measuring the RF characteristics of components in the UHF range 210-610 MC. In addition to performing conventional Q Meter measurements, in which the unknown component is resonated with the internal calibrated capacitor, the output of the oscillator and input of the resonance indicator are available externally for directly measuring the Q of components such as cavities.





F. L. Moseley Company Autograph X-Y Recorders plot directly in Cartesian coordinates any test data which can be reduced to electrical form. As a curve follower, it will control many industrial and manufacturing processes. Used in laboratories and industrial plants throughout the world.

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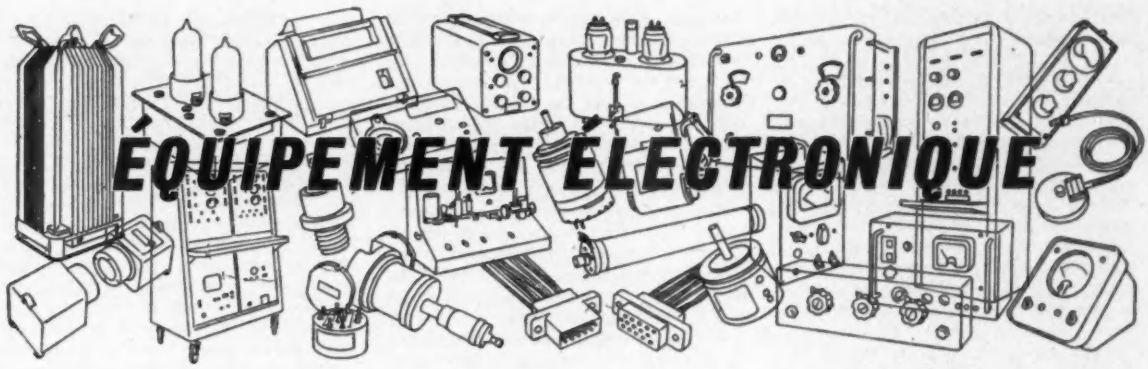


ÉQUIPEMENT ÉLECTRONIQUE

Une description basée sur des renseignements fournis par les fabricants de nouveaux organes, accessoires et instruments d'essai

Traduction des pages 532 à 537

APPAREIL ÉLECTRIQUE DE REPORT DE CHAMP

George Kelk Ltd, 5 Lesmill Road, Don Mills, Ontario, Canada

(Illustration à la page 532)

L'appareil de report de champ électrique Kelk modèle F103A est un dispositif autonome conçu pour la solution par analogie rhéo-électrique des problèmes comportant l'équation de champ de Laplace, tels que ceux se rapportant aux flux de chaleur et de fluides et aux champs électrostatiques ou magnétiques.

L'appareil se compose d'une planche plate de report de 0,371 m² avec unité en pont incorporée et alimentation, d'un bilanmètre à zéro central et de commandes.

Pour utiliser l'appareil, on place du papier conducteur sur la surface de report et l'objet en cours d'examen est simulé par des conducteurs à résistance réduite peints sur le papier.

Des potentiels de limite et jusqu'à cinq potentiels de pression intermédiaires sont établis par des potentiomètres à dix tours individuels. Ces potentiels sont appliqués, au moyen de câbles à bornes appropriées, aux éléments conducteurs, afin d'établir une analogie électrique bidimensionnelle de l'objet physique et des réseaux de champ s'y rapportant.

Un style relié à un circuit d'équilibrage de zéro à haute résolution dans l'élément en pont est utilisé en liaison avec le bilanmètre pour explorer la surface du papier conducteur. De cette façon, des contours de champ électrique peuvent être étudiés et tracés pour reproduire leurs contreparties physiques.

L'appareil de report donne une définition de 0,05% du champ total et une linéarité de pont de 0,1%. L'alimentation du modèle classique est de 115 V, 60 Hz, 15 W. Des appareils peuvent être livrés, cependant, pour d'autres tensions et d'autres fréquences.

EE 36 751 *pour plus amples renseignements*

ALIMENTATION KLYSTRON

Mid-Century Microwavegear Ltd, 19 Parsons Mead, West Croydon, Surrey

(Illustration à la page 532)

Le bloc d'alimentation klystron type EE.4 fournit l'alimentation en haute tension nécessaire à l'utilisation des klystrons de la bande K et de la bande Q. On peut varier la tension de résonateur de 1,75 à 2,25 kV à un courant maximum de 20 mA, le réflecteur peut être négatif de 50 à 450 V par rapport à la cathode et la grille peut être négative jusqu'à 200 V. L'alimentation de chauffage est un courant continu, stabilisé à 6,3 V et allant jusqu'à 1,2 A. Toutes les alimentations sont hautement stabilisées et exemptes d'ondulation. Les possibilités de modulation intérieure comprennent une onde carrée de 3 kHz pouvant être appliquée soit à la grille soit au réflecteur, et une tension en dents de scie de 50 Hz qui peut être appliquée au réflecteur seulement. Des formes d'onde de modulation extérieure peuvent être appliquées à l'une ou à l'autre des électrodes. Toutes les commandes sont fixées sur le panneau frontal, qui comprend, en outre, les instruments de mesure pour la lecture du courant, de la tension de résonateur et de la tension de réflecteur, ainsi qu'une prise Plessey à 6 directions pour les raccordements de klystron.

EE 36 752 *pour plus amples renseignements*

PHASEMÈTRE TRÈS BASSE FRÉQUENCE

Airmec Ltd, High Wycombe, Buckinghamshire

(Illustration à la page 532)

Cet instrument a été étudié pour la mesure précise d'angles de phase dans la gamme de fréquences de 0,01 Hz à 1 kHz. L'indication est directe, et elle prend la forme d'un point lumineux sur la face d'un tube cathodique à longue persistance avec une base de temps circulaire. Une fois achevés les préliminaires nécessaires, on peut obtenir une lecture de l'angle de phase dans un cycle de la tension d'entrée.

L'instrument permet également l'affichage des figures de Lissajous, et l'annulation de la composante de courant continu dans la forme d'onde. De plus, l'amplitude peut être mesurée par la méthode dite du décalage de courant continu.

Les signaux de référence et de quadrature exigés par le phasemètre peuvent être obtenus du générateur de signaux très basse fréquence Airmec type 257 dans la gamme de fréquences commune aux deux instruments soit: 0,03 à 30 Hz. A l'intérieur de ces limites, les deux instruments forment conjointement une combinaison des plus adaptables et d'un intérêt particulier pour les techniciens dans les domaines du contrôle des processus et des commandes asservies.

EE 36 753 *pour plus amples renseignements*

BOÎTE À RÉSISTANCES DE DÉCADES

Level Electronics Ltd, 10-12 St. Albans Road, Barnet, Hertfordshire

(Illustration à la page 532)

Cette boîte à résistances bon marché renferme des résistances Erie à haute stabilité, de la variété à couche pyrolitique pleinement tropicalisée. Ces résistances sont choisies à une valeur de 1% près et leur construction est telle que la résistance en circuit est toujours déterminée par au moins deux résistances individuelles.

Quatre commandes de décades peuvent être obtenues à l'aide de commutateurs rotatifs à onze positions munis de boutons-flèches. Les commutateurs sont à index positifs et les contacts fonctionnent selon le principe de l'action à couteau.

Le changement de résistance d'une position de commutateur à une autre est clairement défini sans que survienne une valeur intermédiaire quelconque ou un état de circuit ouvert.

Les résistances sont complètement enfermées à l'intérieur d'un boîte métallique reliée à une borne de blindage à part.

La gamme de résistances de la boîte s'étend de 10Ω à 111,1 kΩ, par intervalles de 10Ω, avec une précision de ±1% à n'importe quelle valeur choisie. La puissance nominale est de 3W à 43°C et de 2W à 70°C, le coefficient de température étant inférieur à 0,05%/°C.

EE 36 754 *pour plus amples renseignements*

RÉSISTANCES A HAUTES VALEURS

Alma Components Ltd, 551 Holloway Road, London, N.19

Ces résistances ont été réalisées à l'aide de fil métallique très fin pour permettre le bobinage à des valeurs très élevées et à des tolérances réduites, dans le mininuon d'espace possible.

La carcasse est en céramique non-hygroscopique ayant des propriétés isolantes élevées et une grande résistance mécanique. Le revêtement est en résine d'epoxyde, adhérant fortement à la carcasse et au fil métallique afin d'assurer la protection nécessaire contre l'humidité dans la gamme de 0 à 100°C.

Cette résistance, désignée par le type E, est livrable pour une puissance de 100 kΩ à 10 MΩ avec une tolérance de ±0,05% et un coefficient de température supérieur à ±0,002% par degré centigrade.

EE 36 755 *pour plus amples renseignements*

CHAMBRE D'IONISATION

Plessey Nucleonics Ltd, Weedon Road, Northampton

(Illustration à la page 533)

La chambre d'ionisation PNI a un volume sensible de 5 litres. L'emploi d'isolateurs en céramique et de scellements céramique/métal lui donnent une grande robustesse. De plus, la structure rigide des électrodes garantissent une sensibilité réduite à l'effet Larsen. Une grande variété de gaz de remplissage peuvent être fournis à des pressions pouvant atteindre 20 atmosphères.

La réponse d'énergie au rayonnement gamma peut être nivelée jusqu'à environ 100 kev. Au-dessous de ce niveau, elle tombe brusquement, grâce à l'emploi d'un remplissage mixte d'argon et d'azote, mis au point par le centre de recherches nucléaires de Harwell. La chambre peut être rendue sensible aux neutrons thermiques, si nécessaire, et elle peut être remplie pour fournir l'équivalence approximative des tissus aux neutrons rapides dans une gamme d'énergie étendue.

Un fini de peinture à base de résine d'époxyde est normalement fourni et la plaque de montage de la chambre permet de faire un joint scellé à un coffret de préamplificateur.

EE 36 756 *pour plus amples renseignements*

BLOC D'ACCORD DE TÉLÉVISION À BOUTON-POUSSOIR

Sydney S. Bird & Sons Ltd, 3 Palace Mansions, Palace Gardens, Enfield, Middlesex

(Illustration à la page 533)

Le circuit fondamental de ce bloc d'accord différentiel à bouton-poussoir comprend un amplificateur HF et un oscillateur/mélangeur local. Le courant d'entrée MF du circuit anodique est conduit, aux fins de couplage capacitif de l'extrémité inférieure, vers l'amplificateur MF du récepteur.

Le préréglage des boutons de sélection des voies, à n'importe quelle fréquence voulue, est laissé au soin de l'utilisateur et n'exige que la rotation du bouton vers l'une de ses positions de cliquet. Une nouvelle pression du bouton donne la voie choisie en déplaçant les chaînons de court-circuit jumelés vers la position prédéterminée le long des inductances différentielles.

Des variantes du bloc d'accord fondamental à quatre boutons sont munies de boutons supplémentaires assurant la très haute fréquence/modulation de fréquence à accord continu dans la Bande II, et un point d'injection par commutation à la grille du mélangeur pour l'introduction de la puissance de sortie d'une bloc UHF à part.

Le bloc d'accord PC.80 comporte un dispositif d'accord précis à oscillateur du type "à mémoire". Chaque bouton renferme une commande coaxiale pour le réglage optimum de la fréquence de l'oscillateur local pour la voie connexe préréglée. Le réglage d'accord précis de chaque bouton est entièrement indépendant du réglage des autres boutons. Cette particularité, alliée à la stabilité à long terme du circuit oscillateur et à la précision du réenclenchement, assure un usage minimum du dispositif d'accord précis de la part de l'utilisateur.

EE 36 757 *pour plus amples renseignements*

OSCILLOSCOPE À MEMOIRE

Distributeurs: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Illustration à la page 533)

La société Aveley Electric Ltd. a introduit dans le Royaume-Uni un nouvel oscilloscope d'accumulation Dumont type 430.

Il s'agit d'un élément monobloc compact à amplificateurs X-Y identiques, d'une grande sensibilité et dont la gamme de fréquences va du courant continu à 10 kHz.

D'une manière générale, il peut être classé comme un dispositif de report à largeur de bande de 10 kHz. Son grand écran donne un affichage précis et détaillé, et des circuits spéciaux protègent le tube cathodique et éliminent virtuellemènt tous les risques d'endommagement de l'écran.

Le temps d'effacement est de 15 secondes avec des cycles d'accumulation répétée toutes les 60 secondes. La durée de stockage peut varier de quelques secondes à plusiers jours.

La sensibilité des amplificateurs X et Y est de 10 mV/cm et de 100 V/cm respectivement, par plots commutés avec entrées simples ou équilibrées. Dans l'état équilibré, le quotient de réjection commune dépasse 40 dB. Le décalage de phase d'amplification est inférieur à ±1° du courant continu à 3 kHz.

Un étalonneur intérieur de ±1% est prévu pour l'étalonnage des amplificateurs X et Y.

EE 36 758 *pour plus amples renseignements*

FICHES ET DOUILLES SERTISSABLES

Aircraft Marine Products (GB) Ltd, Ampio House, 87-89 Saffron Hill, London, E.C.1

(Illustration à la page 533)

La société Aircraft Marine Products (G.B.) Ltd., vient d'annoncer l'introduction en Europe de sa gamme de fiches et douilles sertissables. Les logements sont en phtalate phénolique ou dialcoylique et sont livrables en 14, 20, 21, 26, 34, 41, 50, 75 et 104 positions. Les contacts sont dorés sur nickel et sont conçus pour le sertissage soit avec une machine automatique soit avec un outil manuel. Des taux de plus de 1000 applications par heure peuvent être atteints avec la machine automatique. Après le sertissage, le contact est inséré dans les moulages. Les contacts peuvent être introduits et retirés facilement, ce qui constitue un avantage précieux pour les matériels prototypes.

EE 36 759 *pour plus amples renseignements*

MATIÈRES MAGNÉTIQUES

Standard Telephones & Cables Ltd, Connaught House, Aldwych, London, W.C.2

La gamme STC de matières magnétiques "Stanferite" a été élargie et recodée. Nous donnons ci-dessous des détails des ferrites de zinc/manganèse, zinc/nickel et mixtes de la susdite gamme.

La Stanferite SA400 est une matière en ferrite zinc/manganèse de perméabilite moyenne, à faibles pertes et à faible coefficient de température de perméabilité. Cette matière convient aux bobines d'inductance stables de haute qualité, aux transformateurs d'impulsions, etc. et elle peut être utilisée pour des applications accordées atteignant environ 1 MHz. Des fréquences plus élevées peuvent être utilisées pour certaines applications non accordées.

La Stanferite SA600 est une matière en ferrite zinc-manganèse à perméabilité élevée, à faibles pertes et à faible coefficient de température de perméabilité. Elle convient aux transformateurs de bande latérale, aux bobines d'inductance BF, aux transformateurs hybrides, aux têtes d'enregistrement, etc. et elle peut être utilisée pour des applications accordées jusqu'à environ 500 kHz. Des fréquences plus élevées peuvent être utilisées dans certaines applications non-accordées.

Les Stanferrites SB300, SB400, SB500, SB600 et SB700 sont des ferrites nickel/zinc à faible perméabilité, constante diélectrique réduite et très haute résistivité. Elles conviennent aux transformateurs et aux applications analogues. La gamme de perméabilité et de fréquences pour les divers types est comme suite:

Type:	*Perméabilité initiale: (nominale)*	*Gamme de fréquences:*
SB300	15	10 MHz à 150 MHz
SB400	30	1 MHz à 50 MHz
SB500	100	500 kHz à 15 MHz
SB600	200	200 kHz à 5 MHz
SB700	650	50 kHz à 2 MHz

Les Stanferites SC300 et SC500 sont des ferrites mixtes a boucles d'hystérésis rectangulaires, dont les caractéristiques de commutation rapides se prêtent particulièrement à l'emmagasinage des données et aux calculateurs.

La Stanferite SC300 convient aussi bien au stockage des informations qu'à la commutation, et elle est habituellement fournie sous forme de bobines microtoroïdales, quoiqu'elle puisse être livrée en bobines toroïdales d'une dimension maxima de 12 mm.

EE 36 760 *pour plus amples renseignements*

FRÉQUENCEMÈTRE/CAPACIMÈTRE

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Illustration à la page 534)

Ce fréquencemètre/capacimètre type MM1009 est un appareil portatif à batterie, donnant des lectures directes de fréquences (de 0 à 100 Hz et de 0 à 100 kHz) et de capacités (de 0 à 1000 pF et de 0 à 0,3 μF).

Comme fréquencemètre, il a une précision de mesure de $\pm 3\%$ dans cinq gammes allant jusqu'à 10 kHz et de $\pm 5\%$ dans les deux gammes supérieures. Ces degrés de précision sont valables pour un étalement 2 : 1 de rapport repère/espace. Le signal d'entrée (100 mV à 150 V amplitude efficace) est limité et injecté dans un circuit intégrateur du type compteur d'impulsions. A l'aide d'un transducteur d'entrée approprié, on pourrait adapter ce fréquencemètre à lecture directe à diverses applications tachymétriques.

Comme capacimètre, le MM1009 couvre la gamme de 0 à 0,3 μF dans six gammes, avec une précision de $\pm 2{,}5\%$ maintenue dans la gamme de batteries de 8 à 12 volts. Le condensateur inconnu est comparé à l'étalon intérieur par substitution dans le circuit intégrateur. Des étalons convenablement choisis fournissent donc des lectures directes de capacité. La gamme peut être facilement étendue à 1,0μF.

L'appareil est exclusivement muni de semi-conducteurs et il est alimenté par 8 piles U2 à l'épeuve des fuites (Norme Internationale) ou d'un modèle équivalent, d'une durée de vie utile de trois mois.

EE 36 761 *pour plus amples renseignements*

COMPTEUR ÉLECTROMAGNETIQUE

Counting Instruments Ltd, 5 Elstree Way, Boreham Wood, Hertfordshire

(Illustration à la page 534)

Ce nouveau compteur poids léger type 1250 est un modèle à trois chiffres avec préréglage manuel permettant de fixer le compteur sur un chiffre prédéterminé. Lorsqu'il est modulé en impulsions, il soustrait jusqu'à zéro ce qui provoque la fermeture ou l'ouverture d'un des circuits.

Le disjoncteur est conçu de façon à ce que l'appareil puisse être préréglé à n'importe quel chiffre entre zéro et 999.

Il existe des modèles pour la plupart des tensions normales, de 24 V c.c. à 230 V c.a. Un soin tout particulier a été apporté à l'étude de l'appareil, afin d'éviter qu'il ne soit affecté par l'humidité.

EE 36 762 *pour plus amples renseignements*

ENCODEUSES DE POSITION D'ARBRE

Ketay Ltd, Eddes House, Eastern Avenue West, Romford, Essex

(Illustration à la page 534)

Une nouvelle série d'encodeuses de position d'arbre, récemment mises au point par la Division Norden de la United Aircraft Corporation, vient d'être présentée sur le marché anglais par la Sté. Ketay Ltd.

Les applications de ces dispositifs comprennent la commande de machines-outils, les lectures de films, et tous les types d'appareils de navigation, y compris ceux pour la mesure de données variables telles que le cap, le gisement et l'azimut. Le type ADC-36BCD assure le comptage au taux de 360 coups par rotation de l'arbre d'entrée, l'indication numérique de la position d'arbre étant donnée en degrés de numération décimale codée binaire. Un dispositif logique à balai V d'auto-sélection est incorporé à l'encodeuse, rendant ainsi superflus les circuits logiques étendus de sélection à balais extérieurs. L'encodeuse est enfermée dans un synchro boîtier classique "U.S. Bu-Ord", du format 33, grâce à la méthode dite du chiffre binaire fractionné.

Le type ADC-5-BCD (1000) peut compter au taux de 100 000 coups pour 100 tours de l'arbre d'entrée. Comme le type précédent, cette encodeuse à pouvoir séparateur élevé, utilise un dispositif logique à balai V d'autosélection, et la technique du chiffre binaire fractionné permet également de l'insérer dans le plus petit boîtier possible. Fondamentalement, c'est un appareil à 1000 coups par tour.

Le troisième type, assurant un taux de comptage de 1024 coups par rotation d'arbre, est enfermé dans un boîtier synchro classique "U.S. Bu-Ord", du format 22, et donne ses indications en code Gray. Ce dernier modèle est un complément à la gamme Ketay d'encodeuses à code Gray qui comprend un modèle de format 18, à 256 coups par tour, et un format 23, à 512 coups.

EE 36 763 *pour plus amples renseignements*

FOUR À CRISTAL

Marconi's Wireless Telegraph Co. Ltd, Chelmsford, Essex

(Illustration à la page 535)

Ce four a une variation cyclique de température ne dépassant pas $\pm 0{,}0014°C$, qu'on obtient en utilisant la propriété en vertu de laquelle une substance donnée (dans ce cas la naphtaline) passe de l'état solide à l'état liquide à une température qui constitue une constante pour cette substance.

L' avantage pratique de cette méthode, par rapport aux appareils à thermostat classiques, réside dans le fait que le four produit une augmentation considérable du facteur d'amélioration. (Ce dernier est le rapport entre le changement de température extérieure et celle à l'intérieur du four). Dans le cas du F3006 ce rapport est de 250:1 ou davantage, ce qui signifie qu'un changement de température de 25°C au dehors du four ne produirait qu'un changement de 0,1°C à l'intérieur.

Le principe de fonctionnement dépend du fait que tandis que le point de fusion de la naphtaline est toujours constant, le volume de la substance augmente durant le passage de l'état solide à l'état liquide. Cette augmentation est utilisée pour le contrôle de la chaleur appliquée, de sorte qu'en pratique, la température est maintenue au point de fusion et, par conséquent, stable. En d'autres termes, contrairement aux thermostats ordinaires, la méthode de contrôle dite du changement d'état présente une variation négligeable de température cyclique, au-dessus et au-dessous de la température de fonctionnement exigée, car la variation cyclique survient dans la transition d'un état à l'autre.

La température de fonctionnement du four F3006 est de 79,5°C le temps nécessaire pour arriver à 0,2°C près de cette température étant de 35 minutes. Le cycle de commutation à 20°C est de 20 secondes marche, 80 secondes arrêt. L'alimentation du réchauffeur est de 24 à 30 V, 50 Hz, avec une consommation de pointe de 30 W. Un culot octal est utilisé pour ce four.

EE 36 764 *pour plus amples renseignements*

"SYNCHRO INSTRUCTEUR"

Pioneer Designs Ltd, 6 Hampton Court Parade, East Molesey, Surrey

(Illustration à la page 535)

Ce "synchro instructeur", réalisé par la Division Servokits de la Sté. Pioneer Designs Ltd., est le dernier-né de la série des auxiliaires d'instruction dans les principes fondamentaux de commande automatique.

La transmission de renseignements, les liaisons synchrones et les simples problèmes de calcul peuvent être expliqués grâce au synchro instructeur, et l'étudiant peut ainsi étudier les effets de l'échange des connexions des rotors et stators de divers types de synchros dans une variété de montages.

L'appareil est entièrement autonome, étant muni de deux alimentations intérieures de 50 V, 50 Hz, à fusibles séparés, reliés à quatre paires de douilles sur un panneau de commande, à partir duquel on peut effectuer des raccordements aux rotors et aux stators de six synchros fixés au-dessous comme éléments indépendants.

Chaque appareil est livré avec deux émetteurs de commande, un transformateur de commande, émetteur différentiel de commande, un séparateur et un récepteur différentiel de couple. Tous ces éléments sont des synchros de 7,62 cm et à 50 Hz, conformes au modèle standard de l'amirauté britannique, et les branchements des rotors et des stators sont reliés à des douilles sur les panneaux fronteaux des éléments individuels.

Les interconnexions entre les prises d'alimentation sur le panneau de commande et les synchros sont effectuées au moyen de câbles munis de fiches de 3 mm. A l'exception du synchro de couple, prévu pour y fixer des poids à ressorts pour la mesure de couple, le restant des synchros sont munis de cadrans de 7,62 cm et de dispositifs de verrouillage à rotor.

On peut ainsi indiquer les causes de défauts élémentaires et enseigner, avec un minimum d'efforts et d'appareillage, la plupart des principes des servomécanismes.

EE 36 765 *pour plus amples renseignements*

DECADES D'INDUCTANCE

Distributeurs: Wolsey Electronics Ltd, Cray Avenue, St. Mary Cray, Orpington, Kent

(Illustration à la page 535)

Ces décades d'inductance sont prévues pour la construction rapide de circuits de filtrage, de circuits équivalents électroacoustiques, d'égalisateurs, de réseaux expérimentaux, etc., dans la gamme des fréquences audibles. En utilisant de grands noyaux de ferrite cuirassés, les facteurs de qualité (Q) pour les fréquences audibles moyennes sont maintenus au-dessus de 100, avec un bon niveau de stabilité et indépendants de la température. Ces facteurs de qualité (Q) sont indiqués en fonction de la fréquence sur la plaque frontale de chaque élément, la gamme de fréquences allant de 50 Hz à 10 kHz. Un avantage supplémentaire de toutes les décades Grundig réside dans le fait qu'elles sont munies de bornes à prises de courant fixées à l'intérieur de la borne à bouton-poussoir. Ceci est extrêmement utile pour les démonstrations et pour de nombreuses applications de recherches.

Les modèles livrables couvrent la gamme de 1 mH à 1,1 H.

EE 36 766 *pour plus amples renseignements*

COMMANDE BOBINÉE MINIATURE

General Controls Ltd, 13-15 Bowlers Croft, Honywood Road, Basildon, Essex

(Illustration à la page 535)

La Société General Controls Ltd. annonce qu'elle produit maintenant une commande bobinée miniature dissipant 3 W.

Les dimensions de cette commande sont 23,3 mm de diamètre sur 16,8 mm de long et elle est munie d'une carcasse laminée spéciale en verre au silicone et d'un couvercle en laiton. Elle peut être livrée soit avec pattes à barillet, cosses à souder ou branchements spéciaux, soit prête à être insérée directement dans une plaquette de circuit imprimé.

L'enveloppe est moulée en matière au mica X4933/4 et elle peut être fournie comme élément tropicalisé entièrement scellé, avec une valeur de résistance maxima de 50 kΩ.

EE 36 767 *pour plus amples renseignements*

COMPTEUR DE CELLULES SANGUINES

Coulter Electronics Ltd, 2-4 Ashwell Street, St. Albans, Hertfordshire

(Illustration à la page 535)

Le nouveau compteur Coulter, modèle D, a été étudié pour le comptage courant des cellules sanguines dans les laboratoires médicaux.

Le nouveau modèle est une version analogue au compteur classique Coulter, mais plus compacte, utilisant le même principe de base qui consiste à faire passer des cellules sanguines en suspension par un petit orifice, en même temps qu'un courant électrique. Les cellules sanguines individuelles passant par l'orifice produisent un changement d'impédance dans l'orifice, et sont comptées à un taux dépassant 5000 cellules individuelles par seconde. Le nombre de cellules comptées est environ 100 fois plus élevé que celles pouvant être comptées par microscope, afin de réduire l'erreur statistique par un facteur d'environ 10, et ce comptage est complété en 20 secondes.

Le degré élevé de précision et de reproductibilité des résultats obtenus avec cet instrument n'a d'égal que sa simplicité et sa vitesse de fonctionnement. Un petit récipient, contenant un échantillon de sang dilué dans la proportion voulue, est placé sur une plate-forme à ressort de sorte que le tube à orifice se trouve submergé dans l'échantillon. Le comptage s'effectue automatiquement en tournant un robinet de fermeture et en pressant l'interrupteur de comptage. Le résultat est indiqué sur un compteur de décades. Dans le cas des cellules sanguines rouges, ce chiffre est multiplié par 100 pour donner le nombre de millimètres cubes. Le nombre de cellules blanches par millimètre cube est le chiffre indiqué sur le compteur. Après avoir noté l'indication, on enlève le récipient et l'échantillon suivant est placé sur la plate-forme. Nul rinçage ou nettoyage du tube à orifice n'est nécessaire entre les échantillons. L'instrument peut être utilisé sans difficulté aucune par un technicien subalterne et on peut contrôler jusqu'à soixante échantillons par heure.

L'instrument complet (sauf pour la bouteille de trop-plein) est contenu dans un seul coffret mesurant 33 cm × 38 cm et ne pesant que 14,5 Kg.

EE 36 768 *pour plus amples renseignements*

ATTACHES DE CÂBLE

Insuloid Manufacturing Co. Ltd, Sharston Works, Leestone Road, Wythenshawe, Manchester 22

(Illustration à la page 536)

Ces attaches de câble en Nylon "INSULOCK" sont plus solides et plus légères que les barrettes métalliques et résistent à des températures de −80°C à +150°C. Elles sont pourvues d'un dispositif de verrouillage à cames de non-retour qui les empêche de devenir lâches ou de se défaire.

En plus du fait qu'elles sont d'un aspect plus net et plus compact, elles réduisent considérablement le coût du câblage. Résistant aux effets chimiques, elles conviennent à l'utilisation dans toutes les conditions climatériques.

Elles sont livrables en trois formats, soit le type LK.1, le type LK.2 et le type LK.3. Ces trois modèles sont prévus pour lier des groupes de câbles dont le diamètre peut atteindre 14 mm, 27 mm et 50 mm respectivement. Pour des diamètres plus importants, on peut joindre deux ou même trois attaches.

EE 36 769 *pour plus amples renseignements*

SPECTROMÈTRE HF

Telefunken. GmbH, Berlin, Charlottenburg 1, Allemagne

(Illustration à la page 536)

Le spectromètre à large bande HF, type SIG488/1, a été conçu pour l'analyse spectrale rapide d'oscillations HF et se prête à l'utilisation dans les stations de mesure en radioélectricité, les stations d'émission, les laboratoires, etc., pour déterminer la largeur de bande d'émission et le rayonnement hors-bande, et mesurer la diaphonie et la distorsion de modulation.

L'appareil fonctionne selon le principe hétérodyne et tant la gamme d'analyse (±25 kHz au maximum) que la vitesse d'analyse (2 à 3 secondes) sont à variation continue.

La gamme de mesure d'amplitude est de 80 dB et l'affichage d'amplitude est logarithmique. Le spectre est affiché sur un tube cathodique à longue persistance. Pour l'évaluation, une échelle éclairée par projection est prévue, dont l'étalonnage peut être vérifié au moyen d'un générateur de repères d'étalonnage incorporé et d'un diviseur d'étalonnage. Un accessoire à caméra permet l'enregistrement photographique du spectre en liaison avec une caméra automatique.

Le spectromètre SIG.488/1 peut être livré pour montage sur pupitre ou pour pouvoir être logé dans des baies conformes aux normes allemandes DIN ou RETMA. Combiné avec un générateur de signaux auxiliaire, il peut être employé pour la mesure directe dans la gamme de fréquences de 40 kHz à 30 MHz, ou pour la télémétrie (surveillance à distance), en liaison avec un récepteur. Dans ce dernier cas, la gamme de fréquences dépend de la gamme de réception du récepteur.

EE 36 770 *pour plus amples renseignements*

ENREGISTREURS À ÉCRITURE DIRECTE

Distributeurs: Leland Instruments Ltd, 145 Grosvenor Road, Westminster, London, S.W.1

(Illustration à la page 536)

Une nouvelle gamme d'enregistreurs

industriels à écriture directe, fabriquée par Officine Galileo de Florence, est maintenant vendue sur le marché britannique par l'entremise de Leland Instruments Ltd.

Ces enregistreurs qui utilisent la plume à encre ou le style chaud, sont livrables en plusieurs modèles classiques, soit le modèle portatif à plume unique, les modèles à deux ou à quatre plumes, ou bien encore montés sur châssis à roues et à 2, 4, 6, 8, 16 ou 32 voies, permettant ainsi l'enregistrement simultané d'un nombre équivalent de phénomènes.

Les préamplificateurs, qui contiennent les étages amplificateurs de tension, leurs commandes et (si nécessaire) des filtres, comportent des circuits imprimés et des transistors. Ils sont robustes et compacts et peuvent être introduits et retirés rapidement du bloc enregistreur. Il existe un assortiment étendu de préamplificateurs, convenant à n'importe quelle mesure technique.

L'enregistrement à style chaud présente l'avantage d'être en coordonnées cartésiennes, facilitant l'interprétation et la corrélation de l'enregistrement multicanaux. Pour les phénomènes à vitesse réduite, ce système offre un degré élevé de définition et un tracé bien défini. Les instruments multicanaux peuvent être munis d'un enregistreur photographique incorporé, permettant l'examen de phénomènes dont les composantes de fréquence élevée (200 à 800 Hz) ne pourraient être reproduits par des plumes à écriture directe.

Les enregistreurs Galileo fonctionnent sur alimentation de 110 à 220 V, 50 Hz. Leur temps de réponse est de 0,01 secondes et les vitesses de déroulement du papier varient de 2,5 mm/sec. à 100 mm/sec. Si nécessaire, d'autres vitesses de déroulement du papier et un marqueur de temps peuvent être prévus.

EE 36 771 *pour plus amples renseignements*

ACCÉLÉROMÈTRE

Technical Ceramics Ltd, Wood Burcote Way, Towcester, Northamptonshire

(*Illustration à la page 536*)

La société Technical Ceramics Ltd., qui est une filiale du Groupe de compagnies Plessey, a créé un nouvel accéléromètre, type G170, pour les essais de vibrations dans une gamme étendue d'applications. Il est d'une utilité particulière pour l'industrie automobile et l'aviation, ainsi que pour la réalisation de méthodes de conditionnement à l'épreuve des chocs. Il se caractérise spécialement par son poids léger, soit 5 kg seulement, qui permet de l'employer pour l'essai des composants ainsi que des ensembles complets. Il a 1,27 cm de long sur 1,27 cm de diamètre, et il est muni d'un connecteur coaxial subminiature. L'accéléromètre G.170 fonctionne dans une gamme de fréquences de 5 Hz à 3,5 kHz et mesure les chocs et les vibrations dans la gamme de 0,1 à 400 *g*. La température de fonctionnement s'étend de −40°C à +80°C et les unités sont entièrement scellées pour pouvoir résister aux conditions d'humidité élevée.

L'accéléromètre utilise un amplificateur magnétique pour assurer une sensibilité maxima dans une direction coaxiale et une sensibilité minima dans d'autres directions. Une capacitance propre élevée a été réalisée, ce qui permet de mesurer aux basses fréquences en employant un élément à cathode suiveuse.

EE 36 772 *pour plus amples renseignements*

BRIDES DE TRANSISTORS

Jermyn Industries, 74 Lakeside Drive, Bromley, Kent

La bride "Sistaclip" convient aux transistors dont de diamètre varie de 4,8 mm à 6,35 mm c'est à dire tous les transistors compris entre les types OC44 et BCZ11. Elle est faite en cuivre au glucinium de 0,15 mm d'épaisseur et elle est généralement argentée. Ses principaux avantages sont qu'elle n'occupe que très peu de place et qu'elle permet l'introduction et le retrait rapides du transistor.

Il existe également une bride convenant tant au type OC170 qu'au type JEDEC TO5. Elle est aussi en cuivre au glucinium et on peut y insérer des transistors de 7,75 mm à 9,1 mm de diamétre.

Un support plastique, en Nylon ou en matière isolante thermorésistante, est en cours de réalisation pour les transistors de la susdite grandeur. Il permettra de fixer ces transistors directement sur les circuits imprimés ou les châssis. Cette dernière application rapproche le mode de fixation des transistors de la tendance actuelle en faveur du montage direct sur châssis des pièces sur isolateurs d'entrée.

EE 36 773 *pour plus amples renseignements*

POTENTIOMÈTRE DE MESURE D'IMPULSION

Ferranti Ltd, Hollinwood, Lancashire

(*Illustration à la page 537*)

La société Ferranti Ltd. a créé le potentiomètre de mesure d'impulsions type PD.30 pour la mesure précise d'impulsions à haute tension dans les émitteurs de radar et autres circuits d'impulsions.

Ce potentiomètre peut être soit incorporé dans une installation, afin de fournir une possibilité permanente de mesure de tension d'impulsion, soit livré dans un coffret sous forme d'instrument d'essai portatif à l'usage d'un laboratoire. Cet instrument, petit et léger, se compose d'un condensateur dans le vide à haute tension, protégé intérieurement par un cylindre métallique afin d'éliminer les effets des capacités parasites extérieures, et d'un élément inférieur qui peut être aussi bien un condensateur de division de haute tension qu'une résistance de différentiation. Les éléments inférieurs sont protégés par une diode à cathode froide Ferranti type AD.42.

Le potentiomètre PD.30 a été conçu pour contrôler des impulsions de haute tension pouvant atteindre jusqu'à 30 kV et il comporte un choix, par sélecteur, de quatre gammes, donnant deux rapports de division de tension préréglée et deux rapports de différentiation. Les rapports de division de tension sont ordinairement préréglés pour des rapports de 250:1 et de 500:1, les rapports de différentiation étant préréglés pour 7,5 kV/μs/V et 5 kV/μs/V. La capacité d'entrée de l'oscilloscope de mesure a un certain effet sur l'étalonnage, et une marge de 45 pF a été prévue à cet égard. Sur la gamme la plus sensible, donc de 250:1, un changement de 8,5 pF produit environ 1% d'erreur. La capacité maxima du dispositif est de 3,4 ±0,2 pF et la capacité de charge totale est de 6 pF au maximum.

L'instrument est fourni complet avec câbles de raccordement appropriés tant aux connexions de haute tension que de l'oscilloscope. L'effet de dérivation que produit la capacité du câble de raccordement sur l'élément résistif est réduit par l'introduction du câble dans une prise de courant prévue à cet effet et incorporant des résistances d'extrémité. Le câble à haute tension est muni d'une bride qui permet de relier aisément le potentiomètre au circuit d'impulsions à haute tension que l'on mesure, c'est à dire au transformateur d'impulsions de magnétron.

L'oscilloscope utilisé doit avoir une puissance d'entrée à impédance élevée pour toutes les gammes.

EE 36 774 *pour plus amples renseignements*

TRANSFORMATEURS DE RAPPORT

Wayne Kerr Laboratories Ltd, 44 Coombe Lane, New Malden, Surrey

(*Illustration à la page 537*)

Ces transformateurs de rapport Wayne Kerr-Gertsch constituent un moyen précis de fournir et de mesurer des rapports de tension alternative dans une gamme étendue de fréquences. Ils sont généralement utilisés comme étalons de rapport, par exemple, dans les bras de rapport d'un pont, ou comme potentiomètres à tension alternative pour le contrôle des séparateurs, des servomoteurs, des transformateurs et des calculateurs.

Ces nouveaux transformateurs, qui portent la référence RT4 et RT5, fonctionnent sur courant de 30 Hz à 1 kHz et de 50 Hz à 10 kHz respectivement. Ils ont une impédance élevée, une faible impédance efficace de série et un déphasage extrêmement réduit. Dans la gamme des fréquences inférieures, on peut obtenir une précision de rapport de 0,001% tandis qu'on obtient 0,01% dans la gamme supérieure.

Les rapports sont choisis en actionnant cinq commutateurs de décades et un potentiomètre à un seul tour. Ce montage assure une résolution continue et une lecture supérieure à six chiffres significatifs, chaque valeur de rapport étant indiquée comme lecture décimale directe.

Les deux éléments ont une linéarité

terminale de 0,001% et un angle de phase très réduit dans des conditions de charge, la grandeur effective de l'angle dépendant de la fréquence et des réglages de rapport.

L'impédance effective de série du RT4 est de 4 ohms et son inductance d'entrée de 500 H. Les valeurs correspondantes du RT.5 sont de 3 ohms et 150 H. La gamme normale de températures pour les deux transformateurs s'étend de −15°C à +80°C.

Les deux modèles de transformateurs sont livrés en coffret d'aluminium ou montés sur châssis avec capot anti-poussières d'aluminium.

EE 36 775 *pour plus amples renseignements*

COMPTEUR DE LOTS

Thorn Electrical Industries Ltd, Thorn House, Upper Street, St. Martin's Lane, London, W.C.2

(*Illustration à la page 537*)

Le compteur de lots CB.11 est un appareil électronique compact et d'un grande souplesse d'emploi, dont la vitesse de comptage peut atteindre 4000 coups par seconde et un taux par lot de 1 par seconde. Il est destiné aux applications exigeant un taux élevé de production d'articles tels que tablettes et pilules, produites en quantities industrielles et automatiquement emballées. Le compteur peut compter 10 000 unités en un lot et jusqu'à 1 million de lots sans réenclenchement. La grandeur du lot peut être réglée facilement et rapidement au moyen de sélecteurs sur le panneau frontal. Un comptage total de 10 milliards de coups peut être réalisé en utilisant deux compteurs en série.

EE 36 776 *pour plus amples renseignements*

TRANSISTORS MESA

Texas Instruments Ltd, Manton Lane, Bedford

La sté. Texas Instruments a étendu sa gamme de transistors par la présentation récente de trois nouveaux transistors Mésa par diffusion et alliage au germanium, spécialement destinés à l'utilisation dans des amplificateurs à haute fréquence et des circuits de commutation rapide.

Chaque type de transistor est étudié pour faciliter la construction de circuits répondant aux applications suivantes:

2G401—Amplificateur à grand gain MF à 465 kHz et 10 MHz.

2G402—Amplificateur pour hyperfréquences à 100 MHz.

2G403—Circuits logiques et arithmétiques fonctionnant à des taux d'horlogerie de 10 MHz.

Afin d'assurer une parfaite sécurité de fonctionnement dans les conditions ambiantes les plus défavorables, ces transistors sont hermétiquement scellés dans des boîtiers entièrement soudés JEDEC TO-5. Le large espacement des câbles permet l'insertion automatique sur les plaquettes de circuits imprimés des materiels de série.

La technique Mesa de diffusion et alliage assure des courants à fuite réduite, un meilleur fonctionnement à haute fréquence, de bonnes caractéristiques de saturation et une dissipation accrue de puissance.

EE 36 777 *pour plus amples renseignements*

Résumés des Principaux Articles

Un compteur à transistors à autocontrôle automatique, avec affichage numérique par H. I. Messer et W. H. P. Leslie

Résumé de l'article aux pages 484 à 489

Il s'agit ici d'un compteur à transistors à autocontrôle automatique avec affichage numérique et possibilité de lecture numérique indépendante, prévu pour l'usage normal de laboratoire ainsi que pour les systèmes de concentration de données.

Le contrôle automatique se fait avant d'effectuer le comptage voulu et il a pour but de vérifier la précision des circuits de comptage, des circuits de déclenchement, de l'étalon de fréquence et du système d'affichage. Le compteur est exclusivement muni d'éléments interchangeables afin de simplifier l'entretien et le dépannage.

Les méthodes d'atterrissage d'avions et l'avenir par R. E. Young

Résumé de l'article aux pages 496 à 502

L'auteur examine, du point de vue de "l'utilisateur", l'orientation actuelle vers la commande d'atterrissage entièrement automatique en tant que partie de la séquence de vol complète.

Les difficultés, telles que celles d'obtenir l'accord international, qui se présenteraient si l'on voulait obtenir l'adoption universelle d'un système automatique donné, sont esquissées et d'autres méthodes sont proposées commes variantes.

Ces dernières comportent, pour l'atterrissage, le Téléradar/infrarouges combinés et les systèmes terrestres de guidage et, pour le contrôle du trafic aérien, une forme particulière d'affichage d'informations de radar à "couleur d'altitude".

L'accent a été mis en général sur la nécessité de présenter les renseignements nécessaires au pilote de la manière la plus rapide possible et sans qu'aucune ambiguité ne puisse se produire.

Le circuit cascode à couplage cathodique facilite la stabilisation par S. G. Jones et R. S. McClean

Résumé de l'article aux pages 503 à 505

Un circuit d'amplification à gain élevé et à déphasage relativement réduit permet de réaliser une alimentation à haute tension négative de grand rendement dont la stabilité peut être facilement assurée.

Compensateurs de temps de propagation de groupe variable à large bande très haute fréquence par R. Hamer et R. G. Wilkinson

Résumé de l'article aux pages 506 à 510

La méthode dont traite cet article permet de fournir des caractéristiques de temps de propagation de groupe/fréquences à variation continue dans une voie de transmission VHF à large bande. L'application du principe à la réalisation de compensateurs de temps de propagation de groupe variable est expliquée. Deux de ces instruments sont décrits en détail. Ils sont propres à l'utilisation dans les sections moyenne fréquence de 70 MHz des systèmes de transmission radioélectrique sur micro-ondes à modulation de fréquence.

Le premier modèle est destiné à l'emploi dans les systèmes à liaisons de téléphonie multivoies allant jusqu'à 960 voies, ou dans les liaisons de télévision en couleurs à sous-porteuse à 405 lignes. Le second modèle convient à la téléphonie à 1800 voies ou à la télévision en couleurs à sous-porteuse à 625 lignes.

Le fonctionnement des transistors selon le mode à avalanche électronique par M. J. Duckenfield

Résumé de l'article aux pages 511 à 513

La tension au collecteur bien définie d'un transistor saturé permet d'employer des circuits simples pour produire des formes d'ondes d'impulsions et rectangulaires. Utilisés selon le mode à avalanche électronique, les transistors peuvent produire des formes d'ondes à temps de montée très rapide et des puissances de crête de l'ordre de 5W. Certains résultats empiriques obtenus par cette forme d'utilisation sont indiqués par l'auteur, qui donne également des détails des circuits employés.

Le réservoir principal d'un analyseur différentiel numérique par P. L. Owen, M. F. Partridge et T. R. H. Sizer

Résumé de l'article aux pages 514 à 520

Cet article, qui est le second d'une série de quatre articles décrivant le dessin et les détails des circuits d'un analyseur différentiel numérique transistorisé, traite de son réservoir électrostatique principal. Il se compose d'une matrice de noyaux de ferrite à 50 mots × 32 chiffres. La fonction de chacune des composantes dans lesquelles le circuit à mémoire peut être logiquement divisé est décrite en détail.

Un circuit simple pour protéger l'alimentation stabilisée des transistors par D. T. Jovanovic et R. P. Ilic

Résumé de l'article aux pages 521 à 523

Les auteurs décrivent un circuit simple pour la protection des alimentations stabilisées en série des transistors, contre les surintensités et les courts-circuits. Le circuit maintient, durant le fonctionnement, la dissipation du transistor série dans les limites de la valeur admissible, permettant ainsi à l'alimentation de fournir un certain courant de charge, même dans les conditions de court-circuit. De plus, le circuit autorise le réenclenchement automatique de l'alimentation stabilisée après avoir éliminé la cause de la surintensité. A titre d'exemple, les auteurs indiquent le comportement d'une alimentation stabilisée de transistor, de 6,3V et 2,5A, d'une réalisation pratique et utilisant le circuit de protection contre les surcharges dont ils traitent.

La stabilité des tubes de référence à cathodes monocristallines par F. A. Benson et B. Rigg

Résumé de l'article aux pages 524 à 525

La reproductibilité ainsi que la stabilité de la tension de fonctionnement des tubes de référence à décharge luminescente munis de cathodes au molybdène monocristal, sont comparées à celles de tubes analogues à cathodes polycristallines et leur supériorité est démontrée. Les tubes décrits sont à lamelles de cristal coupées de manière à exposer la face (1, 0, 0) et ils sont remplis au néon +0,3% d'argon à une pression de 45mm Hg.

Transistors complémentaires couplés au collecteur par V. Spány

Résumé de l'article aux pages 526 à 527

Cet article décrit le couplage cathodique d'une paire de transistors complémentaires tant pour le mode de fonctionnement bistable que pour le mode astable. Ce dernier permet de produire des formes d'onde du type "phantastron" où la tension de crête à crête est à peu près égale à la tension d'alimentation. Le mode non-régénératif permet la production d'une variété de formes d'onde.

ELEKTRONISCHE GERÄTE

Beschreibung neuer Bauelemente, Zubehörteile und Prüfgeräte auf Grund der von Herstellern gemachten Angaben.

Übersetzung der Seiten 532 bis 537

Aufzeichnungsgerät für elektrische Felder

George Kelk Ltd. 5 Lesmill Road, Don Mills, Ontario, Kanada

(Abbildung Seite 532)

Das Kelk-Aufzeichnungsgerät für elektrische Felder Modell F103A ist ein geschlossenes Gerät, das mit Hilfe rheoelektrischer Analogie Probleme löst, die Anwendung von Laplace-Gleichungen erfordern wie sie z.B. in Verbindung mit dem Fluss von Wärme und Flüssigkeit und elektrostatischen oder magnetischen Feldern auftreten.

Das Gerät besteht aus einem flachen 0,37 m² Auswerttisch mit eingebauter Brücke und Stromversorgung, Ausgleichsanzeige mit Mitten-Nullstellung und Reglern.

Zur Benutzung des Aufzeichnungsgerätes wird leitendes Papier auf die Aufzeichnungsfläche gelegt und der Untersuchungsgegenstand durch auf das Papier gemalte niederohmige Leiter simuliert.

Grenzpotentiale und bis zu fünf Zwischen-Treibpotentiale werden durch zehngängige Einzelpotentiometer eingestellt. Diese Potentiale werden durch Verbindungen mit geeignetem Abschluss an die leitenden Elemente angelegt, um eine zweidimensionale Analogie des physikalischen Gegenstandes und des zugehörigen Feldverlaufes aufzustellen.

Ein an eine Nullungsschaltung hoher Auflösung im Brückenteil angeschlossener Schreibstift wird zusammen mit der Nullanzeige benutzt, um die Oberfläche des leitenden Papiers abzutasten. Auf diese Weise können die Konturen des elektrischen Feldes untersucht und aufgezeichnet werden, um ihr physikalisches Gegenstück darzustellen.

Das Aufzeichnungsgerät hat eine Auflösung von 0,05 % des Gesamtfeldes und eine Brückenlinearität von 0,1 %. Für den Betrieb der Standardausführung sind 115 V 60 Hz 15 W erforderlich. Geräte können auch für andere Spannungen und Frequenzen geliefert werden.

EE 36 751 *für weitere Einzelheiten*

Klystron-Stromversorgung

Mid-Century Microwavegear Ltd, 19 Parsons Mead, West Croydon, Surrey

(Abbildung Seite 532)

Die Klystron-Stromversorgung EE/4 ist ein Hochspannungs-Netzgerät für Klystrons, die im K- und Q-Band arbeiten. Die Resonatorspannung ist bei 20 mA Spitzenstrom von 1,75...2,25 kV regelbar; der Reflektor kann in Bezug auf die Kathode von 50...450 V negativ gemacht werden, und das Gitter kann bis zu 200 V negativ sein. Die stabilisierte Heizgleichspannung ist 6,3 V und liefert bis zu 1,2 A. Alle Spannungen sind hochkonstant und restwellenfrei. Als interne Modulationsmöglichkeiten sind eine 3 kHz—Rechteckwelle für Gitter oder Reflektor und eine 50 Hz—Sägezahnspannung für den Reflektor vorgesehen. Externe Modulationswellenformen können an jede Elektrode angelegt werden. Alle Steuervorrichtungen, die Anzeigeinstrumente für Resonatorspannung und -strom und Reflektorspannung und -strom, sowie eine 6polige Plessey-Steckverbindung für die Klystronverbindungen sind auf der Frontplatte angeordnet.

EE 36 752 *für weitere Einzelheiten*

Phasenmesser für sehr niedrige Frequenzen

Airmec Ltd, High Wycombe, Buckinghamshire

(Abbildung Seite 532)

Dieses Gerät ist für sehr genaue Phasenwinkelmessungen im Frequenzbereich 0,01 Hz...1 kHz ausgelegt. Die Anzeige ist direkt in Form eines helleren Punktes auf dem Schirm einer langnachleuchtenden Elektronenstrahlröhre mit kreisförmiger Ablenkung. Wenn die notwendigen Vorbereitungen einmal ausgeführt worden sind, kann der Phasenwinkel innerhalb einer Periode der Eingangsspannung bestimmt werden.

Einrichtungen zur Darstellung von Lissajousfiguren und Aufhebung der Gleichspannungskomponente einer unbekannten Wellenform sind vorgesehen. Ausserdem kann mit Hilfe der Gleichspannungs - Verschiebungstechnik die Amplitude gemessen werden.

Die für den Phasenmesser erforderlichen Bezugs- und Quadratursignale werden dem Airmec Signalgenerator für sehr niedrige Frequenzen Type 257 über den beiden Geräten gemeinsamen Bereich von 0,03...30 Hz entnommen. Innerhalb dieser Grenzen bilden diese beiden Geräte zusammen eine vielseitige Kombination, die besonders für Untersuchungen in der Servo- und Verfahrensregelungstechnik interessant sind.

EE 36 753 *für weitere Einzelheiten*

Dekadenwiderstand

Levell Electronics Ltd, 10-12 St. Albans Road, Barnet, Hertfordshire

(Abbildung Seite 532)

Dieser preisgünstige Dekadenwiderstand benutzt völlig tropenfeste, isolierte, hochkonstante ERIE-Schichtwiderstände. Diese Widerstände werden am Anfang so ausgesucht, dass ihre Toleranz innerhalb 1% liegt und sind so angeordnet, dass der in der Schaltung liegende Widerstand immer durch mindestens zwei Einzelwiderstände bestimmt wird.

Vier 11stufige Drehschalter mit Zeigerknöpfen sind als Dekadenwähler vorgesehen. Die Schalter rasten ein und sind mit Messerkontakten ausgerüstet.

Die Widerstandsänderung von einer Schalterstufe zur nächsten ist deutlich abgegrenzt; weder Zwischenwerte noch offener Stromkreis treten auf.

Die Widerstände sind vollständig von einem Metallgehäuse umgeben, das mit einer getrennten Abschirmklemme verbunden ist.

Der Widerstandsbereich der Dekade ist von 10Ω bis zu 111,1 kΩ in 10Ω-Stufen mit einer Genauigkeit von ±1% für jeden eingestellten Wert. Das Gerät ist für 3 W bei 43°C und 2 W bei 70°C ausgelegt; der Temperaturbeiwert liegt unter 0,05%/°C.

EE 36 754 *für weitere Einzelheiten*

Hohe Widerstände

Alma Components Ltd, 551 Holloway Road, London, N.19

Diese Widerstände wurden entwickelt, um bei Verwendung sehr dünner Drähte sehr hohe Widerstände in kleinstmöglichem Raum mit engen Toleranzen herstellen zu können.

Der Träger ist aus einem feuchtigkeitssicheren keramischen Werkstoff mit hochisolierenden Eigenschaften und grosser Festigkeit hergestellt. Der Überzug besteht aus einem Epoxyharz, das am Träger und Draht fest anhaftet und über einen Temperaturbereich von 0 ... 100°C Schutz gegen Feuchtigkeit gewährleistet.

Der als Type E bezeichnete Widerstand ist in Werten von 100 kΩ bis zu 10 MΩ mit ±0,05% Toleranz und einem Temperaturbeiwert lieferbar, der besser als ±0,002%/°C ist.

EE 36 755 *für weitere Einzelheiten*

Ionisationskammer

Plessey Nucleonics Ltd, Weedon Road, Northampton

(Abbildung Seite 533)

Die Ionisationskammer PN1 hat einen Nutzrauminhalt von 5 l. Verwendung von keramischen Isolatoren und Keramik - Metall - Verschmelzungen ergibt grosse Festigkeit, und ausserdem wird durch starre Elektrodenkonstruktion geringe Mikrofonie erzielt. Eine grosse Auswahl von Füllgasen mit Drücken bis zu 20 at kann vorgesehen werden.

Bei Benutzung einer von AERE Harwell entwickelten Argon-Stickstoff-Mischung kann der Energiegang für Gammastrahlung bis zu ungefähr 100 keV flach gemacht werden, fällt darunter aber scharf ab. Auf Wunsch kann die Kammer für thermische Neutronen empfindlicher gemacht und so gefüllt werden, dass sie für schnelle Neutronen über einen grossen Energiebereich ungefähr Geweben gleichwertig ist.

Üblicherweise wird die Kammer mit einem Epoxyharzüberzug geliefert; ihre Grundplatte ist für Abdichtung auf dem Gehäuse eines Verstärkerkopfes geeignet.

EE 36 756 *für weitere Einzelheiten*

Druckknopf-Fernsehtuner

Sydney S. Bird & Sons Ltd, 3 Palace Mansions, Palace Gardens, Enfield, Middlesex

(Abbildung Seite 533)

Die Grundschaltung dieses Druckknopf-Tuners mit Zuwachsabstimmung besteht aus einem HF-Verstärker und einem Oszillator-Mixer. Der ZF-Ausgang wird für kapazitive Fusspunktkopplung zum ZF-Verstärker des Empfängers herausgeführt.

Vorwahl des Kanals wird vom Benutzer vorgenommen, der nur den Druckknopf in eine der vorgesehenen Rasterpositionen dreht. Darauffolgendes Drücken des Knopfes stellt den Kanal durch Bewegung gleichlaufender Kurzschlusselemente auf eine vorbestimmte Stellung der Zuwachsinduktoren ein.

Abwandlungen der Standardausführung mit vier Druckknöpfen sehen zusätzliche Knöpfe für UKW-FM-Durchstimmung im Band II sowie einen Umschaltpunkt vor, durch den der Ausgang eines getrennten UHF-Tuners dem Gitter der Mischstufe zugeführt werden kann.

Im Tuner PC80 ist eine "Erinnerungs"-Oszillator-Feinabstimmung eingebaut. In jedem Knopf ist eine koaxiale Steuerung für optimale Einstellung der Oszillatorfrequenz für den vorgewählten Kanal vorgesehen. Die Einstellung der Feinabstimmung ist für jeden Knopf völlig unabhängig von der Einstellung für die anderen Druckknöpfe. Diese Eigenschaft, die Langzeitstabilität der Oszillator-Schaltung und die Wiedereinstellgenauigkeit zusammen gewährleisten, dass die Feinabstimmung vom Benutzer kaum nachgestellt zu werden braucht.

EE 36 757 *für weitere Einzelheiten*

Speicheroszillograf

Vertrieb: Aveley Electric Ltd, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex

(Abbildung Seite 533)

Aveley Electric Limited hat in England einen neuen Speicheroszillografen Type 430 von Dumont eingeführt.

Der Oszillograf ist ein kompaktes, geschlossenes Gerät mit identischen X- und Y-Verstärkern, hoher Empfindlichkeit und einem Frequenzbereich von Gleichspannung bis zu 10 kHz.

Im Grunde genommen kann das Gerät als X-Y-Schreiber mit 10 kHz Bandbreite bezeichnet werden. Die grosse nützliche Schirmfläche gewährleistet mehr Einzelheiten und grössere Genauigkeit; Sonderschaltungen schützen die Elektronenstrahlröhre und beseitigen für alle praktischen Zwecke die Gefahren der Schirmbeschädigung.

Die Löschzeit beträgt 15 s, und der Speichertakt kann alle 60 s wiederholt werden; die Speicherzeit ist von Sekunden bis zu Tagen veränderlich.

Die stufenweise umschaltbare Empfindlichkeit der X- und Y-Verstärker liegt zwischen 10 mV/cm und 100 V/cm mit einzelnen und symmetrischen Eingängen. Für symmetrischen Betrieb liegt die Unterdrückung gleichlaufender Sperrsignale über 40 dB. Die Phasenverschiebung der Verstärker beträgt für Gleichspannung und bis zu 3 kHz weniger als ±1°.

Ein eingebautes ±1 % Normal steht zur Eichung der X- und Y-Verstärker zur Verfügung.

EE 36 758 *für weitere Einzelheiten*

Anwürgbare Stecker und Kupplungen

Aircraft Marine Products (GB) Ltd, Amplo House, 87-89 Saffron Hill, London, E.C.1

(Abbildung Seite 533)

Aircraft Marine Products (G.B.) Limited hat die Einführung ihres Programms anwürgbarer Stecker und Kupplungen in Europa angekündigt. Die Gehäuse sind entweder aus Phenolharz oder aus Diallylphthalat gepresst und für 14, 20, 21, 26, 34, 41, 50, 75 und 104 Positionen lieferbar. Die vergoldeten oder vernickelten Kontakte sind für Anwürgen in einer automatischen Maschine oder mit Handwerkzeug konstruiert. Mit einer automatischen Maschine können bis zu 1000 Arbeitsgänge pro Stunde erzielt werden. Nach dem Anwürgen wird der Kontakt in das Gehäuse eingeschnappt. Die Kontakte können leicht eingesetzt und herausgezogen werden, eine Eigenschaft, die besonders bei Prototyparbeiten von unschätzbarem Wert ist.

EE 36 759 *für weitere Einzelheiten*

Magnetische Werkstoffe

Standard Telephones & Cables Ltd, Connaught House, Aldwych, London, W.C.2

Das STC-Programm der als "Stanferite" bekannten magnetischen Werkstoffe wurde erweitert und erhielt neue Bezeichnungen. Einzelheiten der Magnesium-Zink-, Nickel-Zink- und anderer gemischter Ferrite aus diesem Fertigungsprogramm werden untenstehend gegeben.

Stanferite SA400 ist ein Magnesium-Zink-Ferrit mittlerer Permeabilität, das niedrige Verluste und einen niedrigen Temperaturbeiwert der Permeabilität aufweist. Dieser Werkstoff ist für hochwertige, stabile Induktoren, Impulstransformatoren usw. geeignet und kann in abgestimmten Kreisen bis zu ungefähr 1 MHz eingesetzt werden. Bei gewissen nichtabgestimmten Verwendungszwecken können höhere Frequenzen benutzt werden.

Stanferite SA600 ist ein Magnesium-Zink-Ferrit hoher Permeabilität, das niedrige Verluste und einen niedrigen Temperaturbeiwert der Permeabilität hat. Dieses Ferrit ist für Seitenbandtransformatoren, stabile NF- und Tonfrequenztransformatoren, Hybridtransformatoren, Aufnahmeköpfe usw. geeignet und kann in abgestimmten Kreisen bis zu 500 kHz und bei gewissen nichtabgestimmten Verwendungen bei höheren Frequenzen benutzt werden.

Stanferite SB300, SB400, SB500, SB600 und SB700 sind Nickel-Zink-Ferrite mit niedriger Permeabilität, niedriger Dielektrizitätskonstante und sehr hohem spezifischem Widerstand und für Transformatoren und ähnliche Zwecke geeignet. Permeabilität und Frequenzbereich der entsprechenden Typen ist wie folgt:

Type	Anfangspermeabilität (Nennwert)	Frequenzbereich
SB300	15	10 MHz...150 MHz
SB400	30	1 MHz... 50 MHz
SB500	100	500 kHz... 15 MHz
SB600	200	200 kHz... 5 MHz
SB700	650	50 kHz... 2 MHz

Stanferite SC300 und SC500 sind

Mischferrite, die eine rechteckige Hysterese und schnelle Schaltcharakteristiken für Datenspeicherung und Rechnerzwecke haben.

SC300 ist zum Speichern oder Schalten geeignet und wird normalerweise als Mikroringkern geliefert, kann jedoch als Ringkern bis zu einem Höchstdurchmesser von 11,94 mm hergestellt werden.

SC500 ist für Koinzidenz-Speichermatrizes geeignet und wird normalerweise als Mikroringkern geliefert, kann jedoch auch als Ringkern bis zu einem Höchstdurchmesser von 11,94 mm hergestellt werden.

EE 36 760 *für weitere Einzelheiten*

Frequenz- und Kapazitätsmesser

Solartron Laboratory Instruments Ltd, Cox Lane, Chessington, Surrey

(Abbildung Seite 534)

Der tragbare, batteriebetriebene Frequenz- und Kapazitätsmesser MM1009 gibt direkt ablesbare Anzeigen für Frequenzen (0 ... 100 Hz bis 0 ... 100 kHz) und Kapazitäten (0 ... 1000 pF bis 0 ... 0,3 μF).

Die Messgenauigkeit des Frequenzmessers für die 5 Bereiche bis zu 10 kHz ist ±3% und für die beiden höheren Bereiche ±5%. Diese Genauigkeiten gelten für eine Tastverhältnisstreuung von 2:1. Das Eingangssignal (100 mV_{eff} ... 150 V_{eff}) wird begrenzt und in eine Impulszähler Integrationsschaltung gespeist. Dieser direktanzeigende Frequenzmesser kann mit geeigneten Eingangswandlern für verschiedene Drehzahlmessungen benutzt werden.

Als Kapazitätsmesser überstreicht der MM1009 0...0,3 μF in sechs Bereichen mit einer über Batteriespannungen von 12 V bis 8 V gleichbleibenden Genauigkeit von ±2,5%. Der unbekannte Kondensator wird durch Substitution mit einem internen Normal in der Integrationsschaltung verglichen. Zweckmässig gewählte Normale ergeben daher eine genaue, direkte Kapazitätsanzeige. Der Bereich kann leicht bis zu 1,0 μF ausgedehnt werden.

Halbleiterverwendung gibt bei den benutzten 8 lecksicheren Batterien U2 (Internationale Norm) oder gleichwertigen Typen eine nutzbare Betriebsdauer von drei Monaten.

EE 36 761 *für weitere Einzelheiten*

Elektromagnetischer Zähler

Counting Instruments Ltd, 5 Elstree Way, Boreham Wood, Hertfordshire

(Abbildung Seite 534)

Dieser neue, leichte Zähler 1250 ist ein dreistelliges Modell mit manueller Vorwahl, durch die der Zähler auf eine vorbestimmte Zahl eingestellt werden kann; bei Zuführung von Impulsen wird bis auf Null abgezogen, worauf ein Mikroschalter einen Kreis schliesst oder öffnet.

Die Abschaltvorrichtung ist so angeordnet, dass der Zähler für jede beliebige Nummer zwischen 0 und 999 eingestellt werden kann.

Modelle sind für die meisten Standardspannungen von 24 V Gleichspannung bis zu 230 V Wechselspannung lieferbar. Bei der Konstruktion wurde besonderer Wert darauf gelegt, den Zähler feuchtigkeitsfest zu machen.

EE 36 762 *für weitere Einzelheiten*

Drehgeber

Ketay Ltd, Eddes House, Eastern Avenue West, Romford, Essex

(Abbildung Seite 534)

Eine neue Drehgeber-Baureihe wurde vor kurzem von der Norden Division der United Aircraft Corporation eingeführt und kann jetzt in England von Ketay Limited bezogen werden.

Die Bausteine werden für Werkzeugmaschinensteuerung, Filmabtaster, Navigationsgeräte aller Art einschliesslich der zur Messung von veränderlichen Grössen wie Kurs, Peilung und Azimut benutzten eingesetzt.

Type ADC-36BCD gibt 360 diskrete Impulse für jede Umdrehung des Eingangsschaftes ab, wobei die numerische Angabe der Schaftposition in Graden in Form einer binär-dezimalen Verschlüsselung erfolgt. Eine selbstwählende V-Schleiferlogik ist eingebaut, die eine umfangreiche externe Schleiferwahl-Logikschaltung überflüssig macht. Durch Verwendung der Technik unterteilter Bits kann der Geber in einem Standard US-Bu-Ord-Synchroaufbau Grösse 33 untergebracht werden.

Type ADC-5-BCD (1000) kann für nur 100 Umdrehungen des Eingangsschaftes 100 000 Impulse zählen. Wie in der vorher beschriebenen Type erlaubt die Benutzung einer selbstwählenden V-Schleiferlogik und unterteilte Bittechnik Einbau dieses Gebers mit seiner hohen Auflösung in kleinstmögliche Gehäuse. Im Prinzip ist es eine Vorrichtung, die pro Umdrehung 1000 Impulse gibt.

Eine dritte Type gibt 1024 Impulse pro Schaftumdrehung, ist in einen Standard US-Bu-Ord-Synchroaufbau Grösse 22 eingebaut und gibt einen Gray-Code ab. Dieser Baustein vervollständigt das Ketay-Programm für Gray-Codegeber, das bereits eine Grösse 18 mit 256 Impulsen und eine Grösse 23 mit 512 Impulsen pro Umdrehung umfasst.

EE 36 763 *für weitere Einzelheiten*

Quarzofen

Marconi's Wireless Telegraph Co. Ltd, Chelmsford, Essex

(Abbildung Seite 535)

Dieser Ofen hat eine periodische Temperaturschwankung von nur ±0,001°C, ein Wert, der durch Ausnutzung der Eigenschaft eines gegebenen Materials (in diesem Falle Naphthalin), bei einer bestimmten für das Material konstanten Temperatur vom festen in den flüssigen Zustand überzugehen, erzielt wird.

Der praktische Vorteil dieser Technik über herkömmliche Temperaturregler liegt in der bedeutenden Erhöhung des Verbesserungsfaktors des Ofens (der Verbesserungsfaktor ist das Verhältnis der Änderung der Aussentemperatur zur Änderung der im Ofen auftretenden Temperatur). Dieser Faktor ist für F3006 250:1 oder besser, d.h. für eine Aussentemperaturänderung von 25°C beträgt die im Ofen hervorgerufene Temperaturänderung nur 0,1°C.

Das Arbeitsprinzip beruht darauf, dass zwar der Schmelzpunkt des Naphthalins immer konstant ist, der Rauminhalt des Materials sich jedoch beim Übergang vom festen zum flüssigen Zustand erhöht. Dieses erhöhte Volumen wird zur Regelung der zugeführten Wärme benutzt, so dass in Praxis die Temperatur auf dem Schmelzpunkt gehalten wird und damit konstant ist. In anderen Worten: ungleich den herkömmlichen Thermostaten gibt die Zustandsänderungs-Reglermethode vernachlässigbar kleine periodische Temperaturschwankungen über und unter der erforderlichen Betriebstemperatur, da die periodische Schwankung im Verhältnis Festkörper zu Flüssigkeit auftritt.

Die Betriebstemperatur des Quarzofens beträgt 79,5°C, und es dauert 35 Minuten, bis die Temperatur diesen Wert innerhalb 0,2°C erreicht. Bei 20°C ist der Schalttakt 20 s an, 80 s aus. Die Heizung erfordert 24...30 V 50 Hz mit einem Spitzenverbrauch von 30 W. Ein Oktalsockel wird benutzt.

EE 36 764 *für weitere Einzelheiten*

Synchro-Lehrmaschine

Pioneer Designs Ltd, 6 Hampton Court Parade, East Molesey, Surrey

(Abbildung Seite 535)

Die von der Abteilung Servokits der Pioneer Designs Ltd hergestellte Synchro-Lehrmaschine stellt eine Ergänzung bestehender Lehr- und Ausbildungsmittel dar, die für die Grundprinzipien der automatischen Regelung zur Verfügung stehen.

Datenübertragung, Synchronverbindungen und einfache Rechnerprobleme können unter Benutzung der Synchro-Lehrmaschine dargestellt werden, und der Student kann die Auswirkung des Vertauschens der Rotor- und Statorverbindungen der verschiedenen Synchro-Typen in einer Auswahl von Anordnungen selbst untersuchen.

Die Lehrmaschine ist ein abgeschlossenes Gerät mit zwei getrennt gesicherten 50 V 50 Hz Stromversorgungen, die zu vier Buchsenpaaren auf der Schalttafel herausgeführt sind, von denen beliebige Verbindungen zu den Rotoren und Statoren der sechs Synchros,

die unten als Einzelbausteine eingebaut sind, hergestellt werden können.

Jede Maschine ist mit zwei Steuersendern, einem Regeltransformator, einem Differential-Steuersender, einem Auflöser und einem Differential-Drehmomentempfänger ausgestattet. Alle diese Bausteine sind 3″ (76 mm) 50 Hz Synchros des Admiralitätsbaumusters, deren Rotor- und Statorverbindungen zu den Frontplattenbuchsen der Einzelbausteine herausgeführt sind.

Verbindungen zwischen Stromversorgungsbuchsen der Schalttafel und den Synchros erfolgt mittels mitgelieferten Verbindungsschnüren, die mit 3 mm-Steckern versehen sind. Zur Drehmomentmessung kann der Drehmomentsynchro mit Federwaagen oder Gewichten belastet werden. Die anderen Synchros sind mit 76 mm-Skalen und Rotor-Feststellvorrichtungen ausgerüstet.

Die Ursache einfacher Fehler kann vorgeführt werden, und ein grosser Teil der Grundlagen der Servomechanik kann mit einem Minimum von Geräten und Mühe beigebracht werden.

EE 36 765 *für weitere Einzelheiten*

Induktivitätsdekaden

Vertrieb: Wolsey Electronics Ltd, Cray Avenue, St. Mary Cray, Orpington, Kent

(Abbildung Seite 535)

Diese Induktivitätsdekaden sind für den schnellen Aufbau von Filterschaltungen, elektroakustischen Ersatzschaltungen, Entzerrern, versuchsmässigen Netzwerken usw. im Tonfrequenzbereich gedacht. Durch Verwendung grosser Ferrit-Schalen wird der Gütefaktor Q für mittlere Tonfrequenzen bei guter Stabilität und Temperaturunabhängigkeit über 100 gehalten. Die Gütefaktoren Q werden als Funktion der Frequenz auf der Frontplatte jedes Gerätes gezeigt, dessen Frequenzbereich 50 Hz...10 kHz überstreicht. Zusätzlich ist bei allen Grundig-Dekaden innerhalb der Daumenklemmen eine Steckerverbindung vorgesehen, was besonders für Vorführungen und viele Laborverwendungen nützlich ist.

Modelle sind für den Bereich von 1 mH bis zu 1,1 H lieferbar.

EE 36 766 *für weitere Einzelheiten*

Miniatur-Drahtregler

General Controls Ltd, 13-15 Bowlers Croft, Honywood Road, Basildon, Essex

(Abbildung Seite 535)

General Controls Ltd. kündigt an, dass sie jetzt einen drahtgewickelten Miniaturregler herstellt, der mit 3 W belastet werden kann.

Der Regler hat einen Durchmesser von 23,26 mm und ist 16,76 mm tief. Ein Spezialträger aus Silikon-Glasfaser-Schichtstoff sowie ein angedrückter Messingdeckel werden benutzt. Der Regler kann entweder für Kabelschuhe, mit Lötfahnen, Anschlussdrähten oder Stiften für Leiterplatten geliefert werden.

Das Gehäuse ist aus mit Glimmer gefülltem X4933/4 gepresst und kann als völlig abgedichtetes, tropenfestes Bauelement mit einem Widerstandshöchstwert von 50 kΩ geliefert werden.

EE 36 767 *für weitere Einzelheiten*

Blutzellen-Zähler

Coulter Electronics Ltd, 2-4 Ashwell Street, St. Albans, Hertfordshire

(Abbildung Seite 535)

Der neue Coulter-Zähler Modell D ist für regelmässige Blutzellenzählung in medizinischen Labors ausgelegt.

Das neue Modell ist eine dem Standardmodell ähnliche, kompaktere Ausführung, die dasselbe Grundprinzip benutzt, nach dem eine Suspension von Blutzellen gleichzeitig mit einem elektrischen Strom durch eine kleine Öffnung geleitet wird. Die einzelnen durch die Öffnung gehenden Blutzellen rufen in der Öffnung eine Impedanzänderung hervor und werden mit einer Geschwindigkeit von über 5000 Einzelblutzellen pro Sekunde gezählt.

Die Anzahl der gezählten Zellen ist ungefähr 100 × grösser als bei der üblichen Mikroskopzählung, um den statistischen Fehler um einen Faktor von ungefähr 10 zu reduzieren. Die Zählung dauert 20 Sekunden.

Die hohe Genauigkeit und Wiederholbarkeit der Resultate, die mit diesem Gerät erreicht werden, entsprechen der einfachen und schnellen Arbeitsweise. Ein Becher mit einer in geeigneter Weise verdünnten Blutprobe wird so auf eine Federplatte gestellt, dass die Röhre mit der Öffnung in die Probe eintaucht. Die Zählung erfolgt nach Betätigung eines Sperrhahns und Drücken des Zählschalters automatisch und wird auf einem Dekadenzähler angezeigt. Für rote Blutzellen wird die Anzeige mit 100 multipliziert und gibt dann die Anzahl pro mm^3. Für weisse Zellen gilt die direkte Anzeige. Nach Notierung der Zählung wird der Becher entfernt und eine neue Probe auf den Stand gestellt. Die Röhre mit der Öffnung braucht weder ausgespült noch sonstwie gereinigt zu werden. Das Gerät kann von einem jungen Laboranten bedient werden, der pro Stunde 60 Zählungen erledigen kann.

Das gesamte Gerät (mit Ausnahme der Abfallflasche) ist in einem Koffer von 33 × 38 cm untergebracht und wiegt 14 kg.

EE 36 768 *für weitere Einzelheiten*

Kabelbinder

Insuloid Manufacturing Co. Ltd, Sharston Works, Leestone Road, Wythenshawe, Manchester 22

(Abbildung Seite 536)

Diese "Insulock"-Kabelbinder aus Polyamid, die so haltbar wie und leichter als Metallschellen sind, können Temperaturen von −80°C ... +150°C ausgesetzt werden. Sie haben eine nicht umkehrbare Nockenverriegelung, die Lockern oder Lösen unmöglich macht.

Sie sehen sauber und kompakt aus und verbilligen ausserdem die Leitungsführung wesentlich. Sie widerstehen chemischen Angriffen und sind für Verwendung unter allen klimatischen Bedingungen geeignet.

Lieferbar in drei Grössen LK.1, LK.2 und LK.3, die für Zusammenbinden von Leitungsbündeln bis zu einem Durchmesser von 14,29 mm, 27 mm bzw. 50,8 mm geeignet sind. Für grössere Durchmesser können zwei oder sogar drei Binder zusammen benutzt werden.

EE 36 769 *für weitere Einzelheiten*

HF-Spektrometer

Telefunken, GmbH, Berlin—Charlottenburg 1, Deutschland

(Abbildung Seite 536)

Das Breitband-HF-Spektrometer SIG 488/1 ist für schnelle Spektralanalyse von HF-Schwingungen gedacht und für Radio-Überwachung, Sender, Labors usw. geeignet, in denen die Senderbandbreite und Strahlung ausserhalb des Bandes ermittelt und Nebensprechen sowie Modulationsverzerrung gemessen werden.

Das Gerät arbeitet nach dem Überlagerungsprinzip, und sowohl der Analysenbereich (±25 kHz max.) als auch die Analysengeschwindigkeit (2...3 s) sind kontinuierlich regelbar.

Der Amplitudenmessbereich überstreicht 80 dB; die Amplitudendarstellung erfolgt logarithmisch auf dem Schirm einer Elektronenstrahlröhre mit langer Nachleuchtdauer. Die Eichung einer zur Auswertung vorgesehenen flutbeleuchteten Skala kann durch einen eingebauten Eichmarkengeber und Eichteiler überprüft werden. Zubehör ermöglicht die fotografische Aufnahme des Spektrums mit einer automatischen Kamera.

Der Spektrograf kann als Tischmodell oder für Einbau in Standard DIN- oder RETMA-Gestelle geliefert werden. Er kann zusammen mit einem Hilfssignalgenerator für direkte Messungen im Frequenzbereich 40 kHz...30 MHz oder mit einem Empfänger für Fernmessung (Fernüberwachung) eingesetzt werden. Im letzteren Falle hängt der Frequenzbereich von der Reichweite des Empfängers ab.

EE 36 770 *für weitere Einzelheiten*

Direktschreiber

Vertrieb: Leland Instruments Ltd, 145 Grosvenor Road, Westminster, London, S.W.1

(Abbildung Seite 536)

Leland Instruments Limited hat in

England den Vertrieb einer neuen Auswahl industrieller Direktschreiber der Officine Galileo in Florenz übernommen.

Die Schreiber benutzen Schreibfedern oder heisse Stifte und können in verschiedenen Standardausführungen geliefert werden: tragbar für 1, 2 oder 4 Schreibfedern oder im fahrbaren Gestell für 2,4, 6, 8, 16 oder 32 Kanäle für gleichzeitige Aufzeichnung entsprechender Vorgänge.

Die Vorverstärkerteile enthalten Spannungsverstärkerstufen, ihre Regler und wenn erforderlich Filter; gedruckte Schaltungen und Transistoren werden benutzt. Für Vorgänge geringer Geschwindigkeit gibt dieses System eine hohe Auflösung und gut abgegrenzte Kurven. Das Mehrkanalgerät hat ein eingebautes fotografisches Aufnahmegerät, das Untersuchung von Vorgängen mit hochfrequenten Komponenten (200...800 Hz) ermöglicht, die durch direktschreibende Federn nicht aufgezeichnet werden würden.

Die Galileo Schreiber sind für Netzanschluss an 110 V oder 220 V 50 Hz ausgelegt, haben eine Ansprechzeit von 0,01 s und Papiervorschübe, die zwischen 2,5 mm/s und 100 mm/s veränderlich sind. Auf Wunsch können auch andere Vorschübe und Zeitmarkengeber geliefert werden.

EE 36 771 *für weitere Einzelheiten*

Beschleunigungsmesser

Technical Ceramics Ltd, Wood Burcote Way, Towcester, Northamptonshire

(Abbildung Seite 536)

Technical Ceramics Limited, eine Firma der Plessey Gruppe, hat einen neuen Beschleunigungsmesser G170 für einen umfangreichen Einsatzbereich in Schwingungstests herausgebracht. Dieser Beschleunigungsmesser ist besonders wertvoll in der Flugzeug- und Kraftfahrzeugindustrie wie auch für die Entwicklung stossfester Verpackungstechniken. Eine wesentliche Eigenschaft ist das geringe Gewicht von nur 5 g, das Verwendung für Prüfung von Bauelementen und auch Baugruppen ermöglicht. Er hat einen Durchmesser von 12,7 mm, ist 12,7 mm lang und mit einer koaxialen Subminiatur - Steckverbindung ausgerüstet. Der G170 arbeitet im Frequenzbereich 5 Hz...3,5 kHz und misst Stoss und Schwingung von 0,1...400 g. Der Betriebstemperaturbereich ist −40° C... +80° C, und das Instrument ist völlig abgedichtet, um es gegen hohe Feuchtigkeit widerstandsfähig zu machen.

Der Wandler des Beschleunigungsmessers benutzt die Biegungstechnik, so dass er in koaxialer Richtung höchstempfindlich, in anderen Richtungen kleinstempfindlich ist. Durch die erzielte hohe Selbstkapazität können Messungen bei niedrigen Frequenzen mit Hilfe eines Kathodenverstärkers durchgeführt werden.

EE 36 772 *für weitere Einzelheiten*

Transistorhalter

Jermyn Industries, 74 Lakeside Drive, Bromley, Kent

Der "Sistaclip" ist für Transistordurchmesser von 4,8 ... 6,35 mm und damit für alle Transistortypen von OC44 bis BCZ11 geeignet. Der Halter ist aus 0,15 mm starkem Beryllium - Kupfer hergestellt und normalerweise versilbert. Die Hauptvorteile sind, dass er sehr wenig Platz in Anspruch nimmt und dass der Transistor sehr leicht ein- und ausgebaut werden kann.

Ein weiterer Halter kann sowohl für OC170— als auch Jedec TO5—Gehäuse Verwendung finden. Dieser Halter wird auch aus Beryllium-Kupfer für Durchmesser von 7,75 ... 9,1 mm hergestellt.

Für dieselben Transistorgrössen wird z.Z. ein Kunststoffhalter aus Polyamid oder PTFE entwickelt. Dadurch wird die direkte Montage dieser Transistorgrössen auf Leiterplatten oder Chassis ermöglicht und der neusten Entwicklungstendenz, Bauelemente auf Durchführungsisolatoren usw. direkt auf das Chassis zu montieren, Rechnung getragen.

EE 36 773 *für weitere Einzelheiten*

Impuls-Messpotentiometer

Ferranti Ltd, Hollinwood, Lancashire

(Abbildung Seite 537)

Ferranti Ltd. hat ein Impuls-Messpotentiometer PD.30 zur genauen Messung von Hochspannungsimpulsen in Radarsendern und anderen Impulsschaltungen herausgebracht.

Das Potentiometer kann entweder als Dauereinrichtung zur Impulsspannungsmessung in eine Anlage eingebaut oder in einem Gehäuse als tragbares Testgerät für Laborzwecke geliefert werden. Das kleine, leichte Gerät besteht aus einem Hochspannungs-Vakuumkondensator, der intern durch einen Metallzylinder gegen externe Streukapazitäten abgeschirmt ist, und einem unteren Bauelement, das entweder aus einem Kondensator für Hochspannungsteilung oder einem Widerstand für Differenzierung besteht. Die unteren Baulemente werden durch eine Kaltkathodendiode Ferranti AD.42 geschützt.

Das PD.30 ist zum Messen von Hochspannungsimpulsen bis zu 30 kV ausgelegt und hat vier über einen Umschalter einstellbare Bereiche, die zwei vorgewählte Spannungsteilerverhältnisse und zwei Differenzierungsverhältnisse vorsehen. Üblicherweise werden die Spannungsteilerverhältnisse 250:1 und 500:1, die Differenzierungsverhältnisse 7,5 kV/μs/V und 5 kV/μs/V vorgewählt. Die Eichung wird durch die Eingangskapazität des Messoszillografen etwas beeinflusst, was mit 45 pF berücksichtigt wird. Im empfindlichsten Bereich 250:1 ruft eine Änderung von 8,5 pF einen Fehler von ungefähr 1 % hervor. Die obere Kapazität des Gerätes ist 3,4 ±0,2 pF und die gesamte Abschlusskapazität max. 6 pF.

Das Gerät wird vollständig mit Anschlusskabeln für Hochspannung und Oszillograf geliefert. Der Nebenschlusseinfluss der Kabelkapazität wird durch Einführung der Zuführung über die mitgelieferte Steckverbindung verringert, in die ausgesuchte Abschlusswiderstände eingebaut sind. Die Hochspannungsleitung ist mit einer Klemme ausgerüstet, durch die das Potentiometer einfach mit der zu messenden Hochspannungs-Impulsschaltung wie z.B. dem Impulstranformator eines Magnetrons verbunden werden kann.

Der einzusetzende Oszillograf muss für alle Bereiche einen hochohmigen Eingang haben.

EE 36 774 *für weitere Einzelheiten*

Verhältnis-Übertrager

Wayne Kerr Laboratories Ltd, 44 Coombe Lane, New Malden, Surrey

(Abbildung Seite 537)

Mit diesen Wayne Kerr-Gertsch Verhältnis-Übertragern stehen genaue Bauelemente zur Schaffung und Messung von Wechselspannungsverhältnissen innerhalb eines grossen Frequenzbereiches zur Verfügung. Typische Verwendungszwecke sind als Verhältnisnormale, z.B. im Verhältnisarm einer Brücke, oder als Wechselspannungspotentiometer zur Prüfung von Auflösern, Servos, Übertragern und Rechnern.

Diese als RT4 und RT5 bekannten neuen Übertrager arbeiten von 30 Hz ... 1 kHz bzw. 50 Hz ... 10 kHz und haben hohe Eingangsimpedanz, niedrige Serienwirkimpedanz und äusserst niedrige Phasenverschiebung. Im niedrigeren Frequenzbereich können Verhältnisgenauigkeiten von 0,001% und über den höheren Frequenzbereich von 0,01% erreicht werden.

Verhältnisse werden durch Betätigung von fünf Dekadenschaltern und einem Potentiometer eingestellt. Durch diese Anordnung wird kontinuierliche Auflösung gegeben, und die Ablesung ist besser als sechs geltende Ziffern; jeder Verhältniswert wird als direkte Dezimalanzeige abgelesen.

Beide Geräte haben eine Endlinearität von 0,001% und unter Belastung einen sehr kleinen Phasenwinkel; die tatsächliche Grösse des Winkels hängt von der Frequenz und dem eingestellten Verhältnis ab.

Die Serienwirkimpedanz des RT4 ist 4Ω und die Eingangsinduktivität 500 H; die entsprechenden Werte für den RT5 sind 3Ω und 150 H. Der Standardtemperaturbereich für beide Übertrager ist −150°C ... +80°C.

Jedes der Geräte kann entweder in einem Aluminiumguss-Gehäuse oder für Gestelleinbau mit Aluminium-Schutzhaube geliefert werden.

EE 36 775 *für weitere Einzelheiten*

Vorwahl-Zählgerät

(Abbildung Seite 537)

Thorn Electrical Industries Ltd, Thorn House, Upper Street, St. Martin's Lane, London, W.C.2

Modell CB.11 ist ein kompaktes und vielseitiges elektronisches Vorwahl-Zählgerät mit einer Zählfrequenz von 4 kHz und einer Vorwahlfrequenz von 1 Hz. Es ist besonders für Verwendung in Fertigungen gedacht, in denen Artikel wie z.B. Tabletten und Pillen mit grosser Geschwindigkeit und in grossen Quantitäten hergestellt und automatisch verpackt werden. Das Gerät kann Mengen bis zu 10 000 in einer Partie und bis zu 1 000 000 Partien ohne Rückstellung zählen. Die Partienmenge kann schnell und einfach durch Vorwähler auf der Frontplatte eingestellt werden. Bei Serienschaltung von zwei Zählgeräten kann bis insgesamt 10 000 000 000 gezählt werden.

EE 36 776 *für weitere Einzelheiten*

Mesa-Transistoren

Texas Instruments Ltd, Manton Lane, Bedford

Texas Instruments hat ihr Transistor-Fertigungsprogramm mit der Einführung von drei neuen diffundiert-legierten Ge-Mesa-Transistoren erweitert, die besonders für HF-Verstärker und schnelles Schalten entwickelt wurden.

Jede der Transistortypen hat Kennwerte, die die Schaltungsentwicklung für folgende Gebiete erleichtern:

2G401—Hochleistungs - ZF - Verstärker für 465 kHz und 10 MHz
2G402—UKW-Verstärker bis zu 100 MHz
2G403—logische und arithmetische Schaltungen mit Taktfrequenzen bis zu 10 MHz

Zur Gewährleistung hoher Betriebssicherheit unter schwierigsten klimatischen Bedingungen werden diese Transistoren in einem geschweissten JEDEC-TO-5-Gehäuse hermetisch verschlossen. Weiter Abstand der Anschlussdrähte ermöglicht automatische Montage auf Leiterplatten in der Fertigungsanlage.

Die diffundiert-legierte Mesa-Technik ermöglicht niedrige Restströme, verbesserten HF-Betrieb, gute Signalbegrenzung und erhöhte Verlustleistung.

EE 36 777 *für weitere Einzelheiten*

Zusammenfassung der wichtigsten Beiträge

Transistor-Zähler mit automatischer Selbstprüfung und Digitalanzeige von H. I. Messer und W. H. P. Leslie

Zusammenfassung des Beitrages auf Seite 484-489

Für normalen Laborgebrauch und Verwendung in der Messwerterfassung wurde ein Transistor-Zähler mit automatischer Selbstprüfung, Digitalanzeige und Klemmen für Entnahme des Digitalsignals entwickelt.

Die automatischen Tests werden vor der gewünschten Zählung durchgeführt und überprüfen die Genauigkeit der Zähl- und Torschaltungen, des gemeinsamen Frequenznormals und des Anzeigesystems. Es werden durchweg Einschubbausteine benutzt, um Fehlersuchen und Wartung zu vereinfachen.

Flugzeuglandungssysteme der Zukunft von R. E. Young

Zusammenfassung des Beitrages auf Seite 496-502

Die Tendenz zur vollautomatischen Landungssteuerung als Teil des vollständigen Flugplans wird vom Gesichtspunkt des "Benutzers" aus untersucht.

Die der allgemeinen Einführung eines automatischen Systems entgegenstehenden Schwierigkeiten wie z.B. der Abschluss internationaler Abkommen werden umrissen und alternative Methoden vorgeschlagen.

Diese Methoden sind: zum Landen eine Kombination von Infrarot- und Teleradar sowie ein Bodensystem für "erfasste Information" und für den FS-Kontrolldienst eine besondere Form der Radardarstellung in "Höhenfarben".

Durchweg wird betont wie notwendig es ist, dass die Information dem Personal mit der grössten Schnelligkeit und ohne dass in irgendwelcher Form Zweideutigkeit entsteht vorliegt.

Konstruktionsvereinfachung von Stabilisatoren durch eine kathodengekoppelte Kaskodeschaltung von S. G. Jones und R. S. McClean

Zusammenfassung des Beitrages auf Seite 503-505

Eine Verstärkerschaltung mit hohem Verstärkungsgrad und verhältnismässig kleiner Phasenverschiebung ermöglicht die Konstruktion einer negativen Hochleistungs-Hochspannungsquelle, in der Stabilisation leicht erzielt werden kann.

Regelbarer Breitband-Gruppen-Verzögerungsentzerrer für UKW von R. Hamer und R. G. Wilkinson

Zusammenfassung des Beitrages auf Seite 506-510

Eine Methode, die in einer Breitband-UKW-Verbindung kontinuierlich regelbare Gruppen-Verzögerungs/Frequenz-Charakteristiken ergibt, wird beschrieben. Die Anwendung des Prinzips auf die Berechnung eines regelbaren Gruppen-Verzögerungsentzerrers wird erläutert und zwei derartige Geräte werden beschrieben, die für Verwendung in 70 MHz—ZF-Teilen eines Mikrowellen-FM-Radiosystems geeignet sind.

Das erste Modell ist für Mehrkanal-Telefonieverbindungen bis zu 960 Kanälen oder 405 Zeilen-Unterträger-Farbfernsehverbindungen geeignet; das zweite ist für 1800 Kanal—Telefonie oder 625 Zeilen-Unterträger-Farbfernsehen.

Transistoren in der Avalanche-Betriebsweise von M. J. Duckenfield

Zusammenfassung des Beitrages auf Seite 511-513

Die eindeutige Kollektorspannung eines gesättigten Transistors erlaubt Benutzung einfacher Schaltungen zur Erzeugung von Impulsen und Rechteckwellenformen. In der Avalanche-Betriebsweise können Transistoren Wellenformen mit sehr kurzer Anstiegszeit und Spitzenleistungen, die bei 5 kW liegen, erzeugen. Einige mit dieser Arbeitsweise gewonnene Erfahrungsergebnisse werden mit Einzelheiten der benutzten Schaltungen angegeben.

Der Hauptspeicher eines Digital-Differentialanalysators von P. L. Owen, M. F. Partridge und T. R. H. Sizer

Zusammenfassung des Beitrages auf Seite 514-520

Dieser Beitrag ist der zweite einer vierteiligen Abhandlung der Konstruktion und Schaltung eines transistorisierten Digital-Differentialanalysators und behandelt den Hauptspeicher, der aus einer Ferritkernmatrix mit einer Kapazität von 50 Worten mit je 32 Ziffern besteht. Die Funktion jeder der Komponenten, in die die Speicherschleife logisch unterteilt werden kann, wird eingehend beschrieben.

Eine einfache Schutzschaltung für stabilisierte Netzgeräte von D. T. Jovanovic und R. P. Ilic

Zusammenfassung des Beitrages auf Seite 521-523

Eine einfache Schaltung zum Schutz gegen plötzliche Uberlastung oder Kurzschluss serienstabilisierter Transistor-Netzgeräte wird beschrieben. Wenn die Schaltung in Betrieb kommt, gewährleistet sie, dass die Verlustleistung des Serientransistors den zulässigen Wert nicht überschreitet und dass das Netzgerät selbst bei Kurzschlussbedingungen einen bestimmten Strom abgibt. Ausserdem erfolgt durch die Schaltung eine automatische Rückstellung des Netzgerätes, sowie die Uberlastungsursache beseitigt ist. Als Beispiel wird das Verhalten eines praktisch ausgeführten Netzgerätes für 6,3 V und 2,5 A beschrieben, in dem diese Schutzschaltung benutzt wurde.

Die Stabilität von Bezugsröhren mit einkristallinen Kathoden von F. A. Benson und Rigg

Zusammenfassung des Beitrages auf Seite 524-525

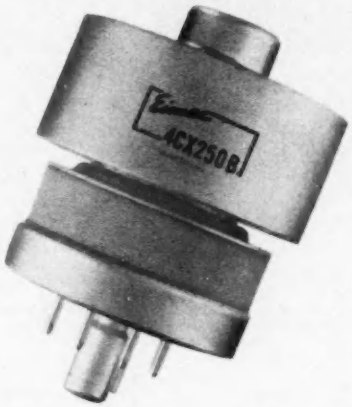
Die Reproduzierbarkeit und Stabilität der Brennspannung von Bezugs-Glimmröhren mit Einkristall-Molybdänkathoden zeigt sich im Vergleich denen für ähnliche Röhren mit mehrkristallinen Kathoden überlegen. Die in den beschriebenen Röhren verwendeten Kristallscheiben sind so geschnitten, dass die (1,0,0)—Ebene freiliegt und sind mit Neon +0,3% Argon unter einem Druck von 45 mm Hg gefüllt.

Kollektorgekoppelte Ergänzungspaare von V. Spány

Zusammenfassung des Beitrages auf Seite 526-527

Dieser Beitrag beschreibt die Kollektorkopplung eines Paares sich ergänzender Transistoren sowohl in der bistabilen als auch in der astabilen Betriebsweise. In der astabilen Wirkungsweise wird die Erzeugung von Rechteckwellenformen der Phantastron-Art möglich, deren Spitze-zu-Spitze-Spannung fast der Speisespannung gleich ist. Die nichtschwingende Arbeitsweise ermöglicht die Erzeugung einer Auswahl von Wellenformen.

WALMORE ELECTRONICS LIMITED



MEDIUM POWER TETRODES

Eimac®

Eitel-McCullough Inc. pioneered the modern line of development in medium power tetrodes when they introduced the 4X150A. Since then they have maintained their leadership by continuous improvements and new developments. The Eimac range gives the widest choice of valves in this category, and they are established generally in equipments throughout the world.

The 4CX250B is the modern version of the 4X150A and 4X250B. Features of the 4CX250B are

Fully ceramic construction.
Longer life expectancy.
Higher seal temperature ratings.
Plug-in replacement for 4X150A, 4X250B.

SELECTION FROM EIMAC RANGE

Type	Anode Dissipation (watts)	Frequency for Max. Ratings (Mc/s)	Brief Description
4X150A	250	150	
4X150D	250	150	26.5 v. heater version of 4X150A
4X150G	250	500 (C.W.) 1500 (pulse)	U.H.F. version of 4X150A
4X250B	250	500	Improved 4X150A, partly ceramic construction
4CX250B	250	500	Improved 4X250B, fully ceramic
4CX250F	250	500	26.5 v. heater version of 4CX250B (Modern 4X150D)
4CX250K	250	500 (C.W.) 1500 (pulse)	U.H.F. version 4CX250B (Modern 4X150G)
4CX250M	250	500 (C.W.) 1500 (pulse)	26.5 v. heater version of 4CX250K
4CX300A	300	500	Rugged tube, stacked ceramic construction
4CN15A	15	500	Pulse version 4CX300A; smaller, lighter
4CX125C	125	500	4CX300A with different cooler system
4W300B	300	500	Water cooled version 4X250B

SOME NEW TYPES

Y249	250	150	Rugged 4X150D
Y252	250	500	Rugged 4CX250B
Y253	300	500	Rugged 4W300B

Eimac — EITEL-McCULLOUGH INC., CALIFORNIA, U.S.A.	CERBERUS A.G. SWITZERLAND (Cold Cathode Tubes)	MOTOROLA SEMICONDUCTOR PRODUCTS INC. ARIZONA, U.S.A.
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and the lowest noise.....

Advanced electronic research by Hitachi technicians has now resulted in the development of a superb frame grid type twin triode (6R-HH8) with excellent high gain and low noise characteristics. As a component of the tuner, the 6R-HH8 ensures an excellent picture with a remarkable degree of definition.

fig. 1 Gain characteristics

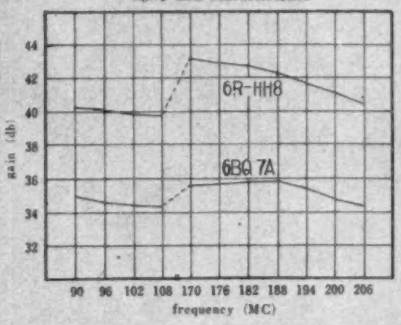
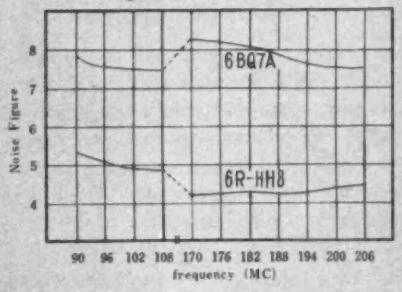
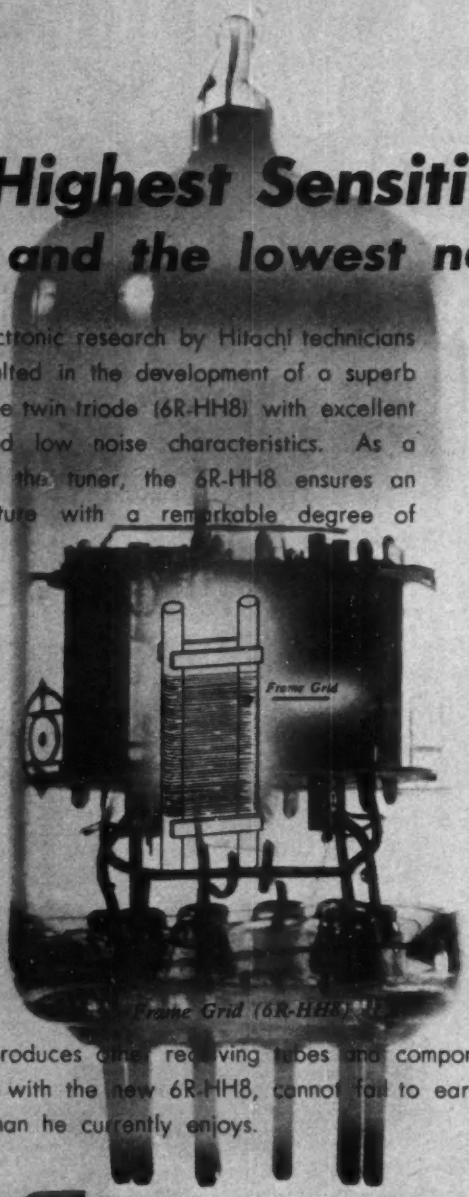


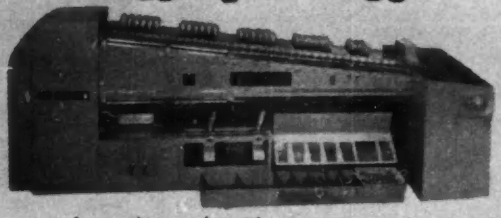
fig. 2 Noise characteristics





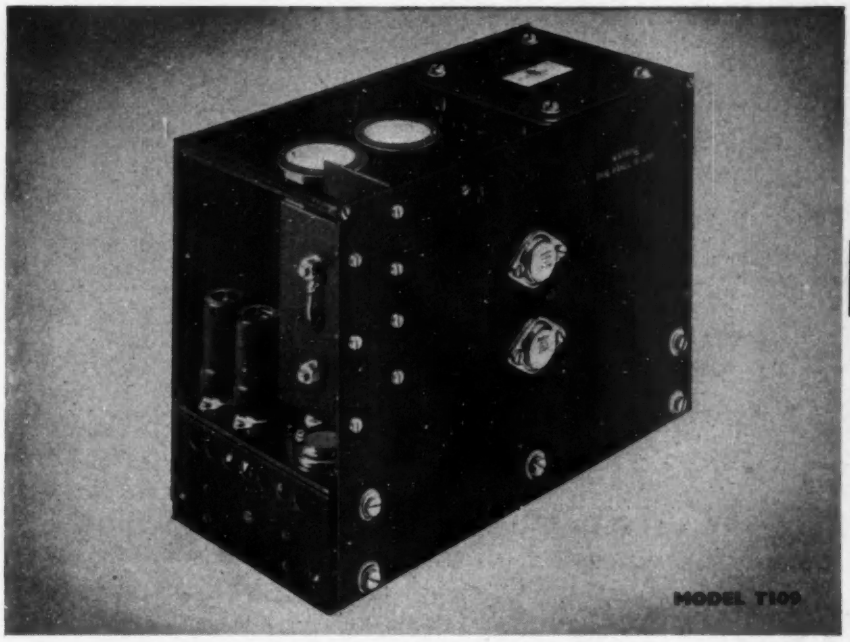
Frame Grid (6R-HH8)

Hitachi also produces other receiving tubes and components for television which, when used together with the new 6R-HH8, cannot fail to earn any maker a market reputation even better than he currently enjoys.



Automatic tube testing equipment

Hitachi, Ltd.
Tokyo Japan
Cable Address: "HITACHY" TOKYO



ROBAND

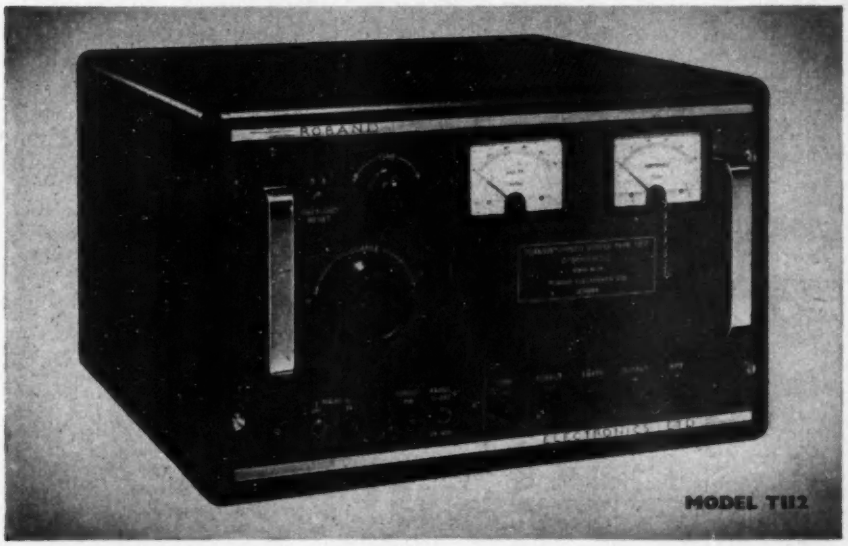
TRANSISTORISED REGULATED POWER SUPPLIES

MODEL	D.C. OUTPUT (FLOATING) VOLTS	AMPS	EFFECTIVE RESISTANCE Ω	% VOLTAGE STABILITY	RIPPLE IN mV	SIZE IN INCHES L	X D	X HT	WEIGHT IN LBS.	EX-WORKS £	S.	D.
T SERIES OPEN CHASSIS PRE-SET VOLTAGE UNITS (Mains 200/250V A.C. 100/125V models also available)												
T98	6–18	0·5	0·08	0·1	1·0	5½	2⅝	4 7/16	3¾	32	0	0
T100	30 max.	1·0	0·04	0·1	1·0	7½	4½	5¾	5½	45	0	0
T108	50 max.	1·0	0·1	0·1	1·0	8½	5½	6½	8	55	0	0
T109	50 max.	2·0	0·05	0·1	1·0	10¾	5½	7½	13	70	0	0
T110	30 max.	5·0	0·01	0·1	1·0	13½	8½	7¾	23	98	0	0
T114	30 max.	10·0	0·01	0·1	1·0	17	10	8½	39	135	0	0

Please order as follows: Type No./Voltage required. For example: T109/45 is a 45 volt 2A unit.

T SERIES FRONT PANEL VARIABLE UNITS (Mains 200/250V A.C. 100/125V models also available)												
T99	0–30	0·5	0·1	0·1	1·0	9¾	5½	5	8	64	10	0
T101	0–50	1·0	0·1	0·1	1·0	13½	10½	9¾	19½	93	0	0
T102	0–30	2·0	0·05	0·1	1·0	16¾	10½	10¾	30	100	0	0
T103	0–30	1·0	0·05	0·1	1·0	13½	10½	9¾	19½	85	0	0
†T104	0–30	1·0	0·05	0·1	1·0	16¾	10½	10¾	30	129	0	0
	0–30	1·0	0·05	0·1	1·0							
T105	0–50	2·0	0·05	0·1	1·0	16¾	10½	10¾	30	118	0	0
T106	0–100	1·0	0·1	0·1	2·0	*21½	14½	11¾	46	149	0	0
T107	0–100	2·0	0·1	0·1	2·0	*21½	14½	11¾	60	183	0	0
T111	0–50	5·0	0·01	0·1	2·0	*21½	18½	11¾	64	155	0	0
T112	0–50	10·0	0·01	0·1	2·0	*21½	20½	13½	101	245	0	0
T113	0–30	20·0	0·01	0·1	2·0	*21½	21	16¾	139	315	0	0

*Panel and chassis withdrawable to fit 19" rack. †Note that T104 has two independent floating sections.



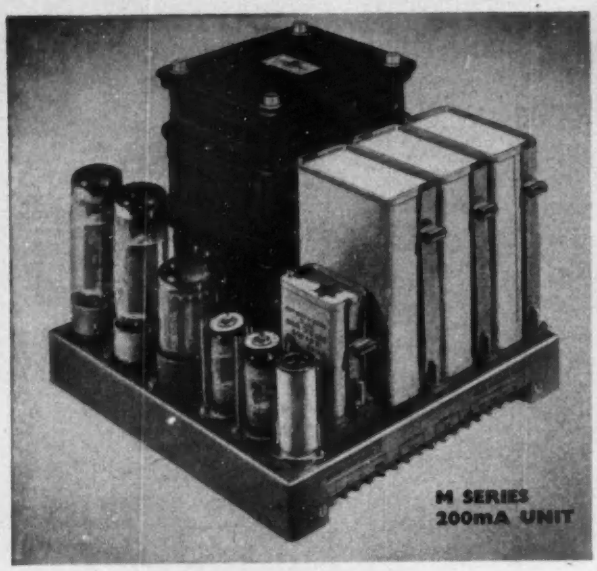
The Roband philosophy of power supplies is to provide *exactly* your *specific* requirements in units of lasting reliability. Roband probably manufacture the widest and most comprehensive range of power supplies available anywhere today. Unrivalled Roband reliability is built into the power supplies by unstinted use of high grade components, interservices approved wherever practical, and by consistently underrunning them—transistors for example at never more than 50% of manufacturers' ratings. Painstaking Roband engineering ensures ample ventilation and mechanical strength for the severest conditions.

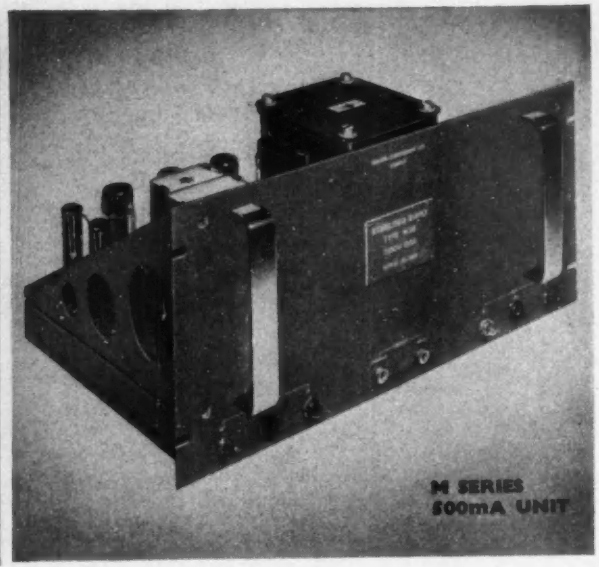
All outputs are isolated to provide highly stabilised positive, negative, or floating supplies with negligible ripple.

Open chassis units are supplied pre-set to any voltage from zero nominal (the T98 starts at 6v) to maximum, a pre-set control allowing a small variation. Any other voltage can be obtained by simple adjustment within the unit.

Made and guaranteed by
ROBAND ELECTRONICS LIMITED
BEULAH WORKS, BEULAH ROAD,
THORNTON HEATH, SURREY
Telephone: LIVingstone 6606

EE 36 120 *for further details*





ROBAND

VACUUM TUBE REGULATED

MODEL	D.C. OUTPUT (FLOATING) VOLTS	mA	A.C. OUTPUTS IN AMPS. (ALL 6·3V)	EFFECTIVE RESISTANCE Ω	% VOLTAGE STABILITY	RIPPLE IN mV	SIZE IN INCHES L	X D	X HT.	WEIGHT IN LBS.	EX-WORKS £ S. D.
M SERIES OPEN CHASSIS UNITS (Mains 200/250V A.C. 115V models also available)											
M22	150	0–20	Nil	0·1	0·02	1·0	4½	3½	4½	2½	26 0 0
M22A	200	0–20	Nil	0·1	0·02	1·0	4½	3½	4½	2½	26 0 0
M23	150	0–50	2 & 1	0·1	0·02	1·0	6	5½	5½	6	27 10 0
M23A	200	0–50	2 & 1	0·1	0·02	1·0	6	5½	5½	6	27 10 0
M33	250	0–50	2 & 1	0·1	0·02	1·0	6	5½	5½	6	27 10 0
M33A	300	0–50	2 & 1	0·1	0·02	1·0	6	5½	5½	6	27 10 0
M14A	100	0–100	3 & 3	1·0	0·02	1·0	10¾	7	6½	14½	63 0 0
M24	150	0–100	3 & 3	0·1	0·02	1·0	7¾	6¾	6½	12¾	33 10 0
M24A	200	0–100	3 & 3	0·1	0·02	1·0	7¾	6¾	6½	12¾	33 10 0
M34	250	0–100	3 & 3	0·1	0·02	1·0	7¾	6¾	6½	12¾	33 10 0
M34A	300	0–100	3 & 3	0·1	0·02	1·0	7¾	6¾	6½	12¾	33 10 0
M25	150	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52 10 0
M25A	200	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52 10 0
M35	250	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52 10 0
M35A	300	0–200	3 & 3	0·1	0·02	1·0	8¾	8½	7	20	52 10 0
M26S	150	30–500	5 & 5	0·1	0·02	1·0	14	11½	8	20	88 0 0
M26SA	200	0–500	5 & 5	0·1	0·02	1·0	14	11½	8	35½	88 0 0
M36S	250	0–500	5 & 5	0·1	0·02	1·0	14	11½	8	35½	88 0 0
M36SA	300	0–500	5 & 5	0·1	0·02	1·0	14	11½	8	35½	88 0 0
M28	150	30–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66 0 0
M28A	200	0–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66 0 0
M38	250	0–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66 0 0
M38A	300	0–350	5 & 5	0·1	0·02	1·0	13½	8¾	6¾	29	66 0 0
M SERIES FRONT PANEL UNITS (Mains 200/250V A.C. 115V models also available)											
M26	150	30–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97 10 0
M26A	200	0–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97 10 0
M36	250	0–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97 10 0
M36A	300	0–500	5 & 5	0·1	0·02	1·0	19	12	8¾	46½	97 10 0
M27	150	50–1·0A	5 & 5	0·1	0·02	1·0	19	15½	8¾	50½	165 0 0
M27A	200	0–1·0A	5 & 5	0·1	0·02	1·0	19	15½	8¾	50½	165 0 0
M37	250	0–1·0A	5 & 5	0·1	0·02	1·0	19	15½	8¾	50½	165 0 0
M37A	300	0–1·0A	5 & 5	0·1	0·02	1·0	19	15½	8¾	50½	165 0 0
M29	150	100–2·0A	5 & 5	0·1	0·C2	1·0	19	18	10½	82½	255 0 0
M29A	200	0–2·0A	5 & 5	0·1	0·02	1·0	19	18	10½	82½	255 0 0
M39	250	0–2·0A	5 & 5	0·1	0·02	1·0	19	18	10½	82½	255 0 0
M39A	300	0–2·0A	5 & 5	0·1	0·02	1·0	19	18	10½	82½	255 0 0

(ALL C.T.)

B SERIES

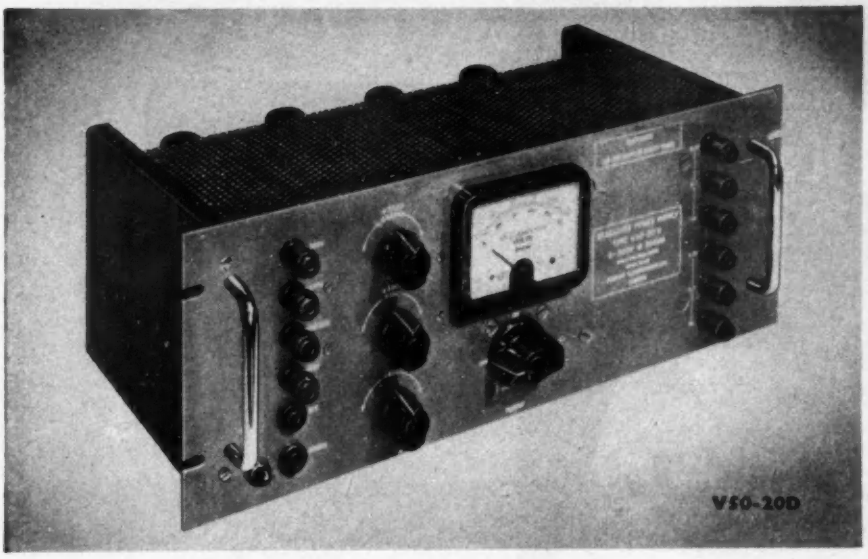
Rugged reliable units

Probably the most advanced series of open chassis units available today and characterised by an extremely rugged construction and a line-up of inter-services approved reliable valves. The input and outputs terminate on **Plessey Mark 4** connectors (or any suitable alternative if requested) and a mains selector panel is included.

A compact welded rectangular framework of extruded angle aluminium alloy rigidly secures the 'C' core transformer and the 14 S.W.G. chassis housing the electronic sub-assembly. Because all the vulnerable components are located within the framework the risk of accidental damage is greatly minimised.

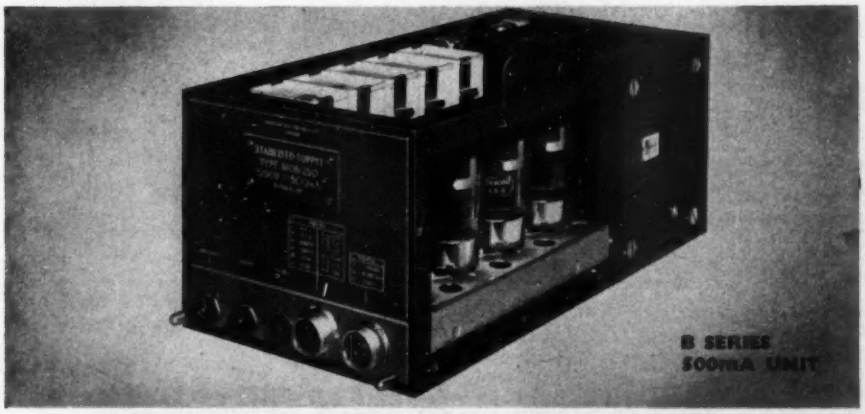
The framework contains anchor nuts which facilitate mounting the units in a variety of ways. It is permissible, for instance to secure any two units side by side to a standard 19" x 7" front panel.

High efficiency silicon junction rectifiers, series valves operating as pentodes and a 'C' core transformer to H2 specification ensure a minimum temperature rise within the unit. Insulated carbon and vitreous wire-wound resistors are used throughout and the conservative design permits continuous operation at full load even when the mains are permanently ±10% from nominal.



POWER SUPPLIES

ROBAND



MODEL	D.C. OUTPUT (FLOATING) VOLTS	mA	A.C. OUTPUTS IN AMPS. (ALL 6·3V)	EFFECTIVE RESISTANCE Ω	% VOLTAGE STABILITY	RIPPLE IN mV	SIZE IN INCHES L × D × HT.	WEIGHT IN LBS.	EX-WORKS £ s. d.
B SERIES RUGGED RELIABLE UNITS (Mains 200 250V A.C. & 100 125V A.C.)									
B101/150	150	30–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/200	200	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/250	250	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/300	300	0–150	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B101/350	350	0–100	3 & 3	0·1	0·02	1·0	9½ 7½ 6½	16	55 0 0
B102/150	150	30–300	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/200	200	0–300	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/250	250	0–250	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/300	300	0–250	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B102/350	350	0–200	5 & 5	0·1	0·02	1·0	14½ 7½ 6½	24	75 0 0
B103/150	150	30–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/200	200	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/250	250	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/300	300	0–500	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0
B103/350	350	0–400	5 & 5	0·1	0·02	1·0	16½ 8 6½	32	95 0 0

ALL C.T.

M SERIES

Open chassis units

Since their introduction some years ago, these chokeless supplies have firmly established their superiority over more conventional circuits.
Their smaller size—excellent high frequency performance and stable operation down to at least 1 c.p.s.—reliability at elevated temperatures and safe operation for ±10% mains changes—coupled with the highest engineering standards confirm the "M" Series as the first choice in stabilised units.

Front panel units

The front panel units have been designed for use with standard 19" racks. The panel is finished in B.S.S.632 grey (or any other colour at no extra cost) and houses the handles, mains and H.T. switches, fuses and indicator lamps. The input and outputs terminate on Plessey Mark 4 connectors (or any suitable alternative if requested) at the rear of the chassis.

V SERIES Regulated

variable voltage units

A range of regulated variable voltage supplies for use on the bench or standard 19" racks. Minimum weight and low internal heat dissipation are obtained by using chokeless circuits, 'C' core transformers, silicon junction rectifiers and series valves operating as pentodes.

V50-50. An exceptionally stable decade controlled 0 to 500V 500mA unit. A fixed 250V 50mA negative rail and two 6.3V 5A centre tapped windings are included.

The decade system enables the output to be changed incrementally with a much greater accuracy than that obtained by normal methods.

Price £137-10-0 ex-works

V50-20D. A 0 to 500V 200mA unit (restricted to 150mA below 200V) of moderate performance. A regulated variable negative rail from 0 to 85V via a 100K potentiometer and two 6.3V5A centre tapped windings are included. A coarse control varies the output from 0 to 500V in one continuous sweep and a fine control is included.

Price £69-10-0 ex-works

2V35-25. A very compact unit containing several regulated output voltages. There are two 0 to 350V 250mA sections (restricted to 150mA below 200V) which may be operated separately, in parallel or in series. Each section has a coarse control to vary the output from 0 to 350V in one sweep and a fine control is included. A fixed 250V 50mA negative rail and two 6.3V5A centre tapped windings are provided.

Price £175-0-0 ex-works

Made and guaranteed by
ROBAND ELECTRONICS LIMITED
BEULAH WORKS, BEULAH ROAD
THORNTON HEATH, SURREY
Telephone LIVingstone 6606

EE 36 122 *for further details*

New! Dramatically Different!

THE
FARNELL
'Hilo-meter'
(PATENT APPLIED FOR)
TRANSISTORISED INDICATOR-CONTROLLER

The Farnell Transistorised "Hilo-meter" is a self-contained unit complete with amplifiers, relays, etc. The plug-in-amplifiers are embodied in one unit of the same diameter as the barrel of the meter, and consequently are mechanically fitted as an extension to the back of the meter case.

The Farnell "Hilo-meter" can continuously indicate electrical variables, and with the provision of high and low limit contacts with automatic control in one instrument, it has very many applications as a controller of Industrial and Electrical measuring systems.

NEW . . . COMPACT . . . TRANSISTORISED ASSURES EFFICIENCY, RELIABILITY EXTREME ACCURACY, AND AUTOMATIC CONTROL.

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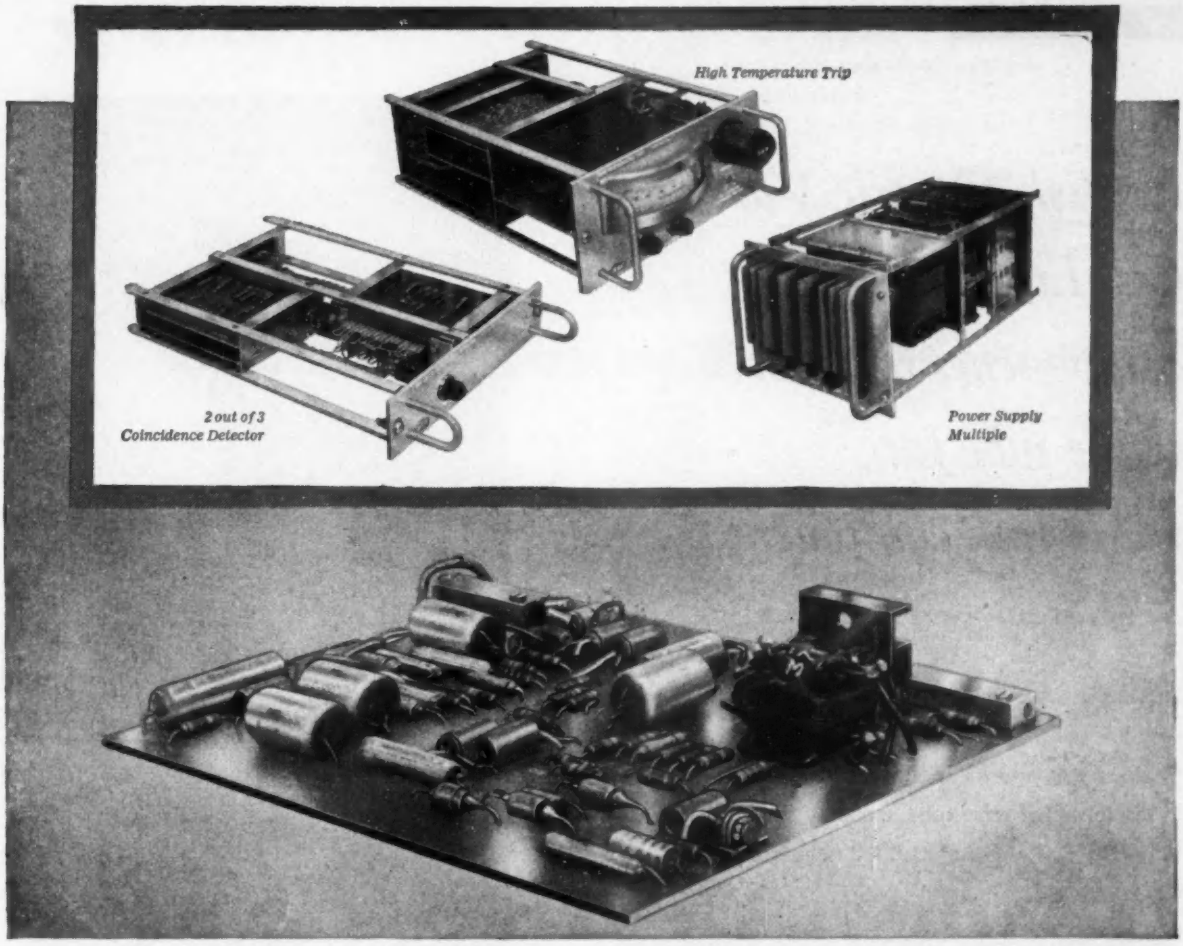


Gains of up to 200,000 over a range of output voltage of ± 5 volts are readily obtainable with the GEC transistorised DC amplifier.

It is a high-gain directly-coupled amplifier providing over accurate amplification of inputs as low as 50 microvolts over a temperature range of +10°C to +45°C. A low value of drift of zero setting accommodates supply line changes and changes of ambient temperature.

Used as the main sub-unit in a number of equipments, this amplifier is suitable for a variety of applications, some of which are illustrated here.

These, in turn, are but a few of an extensive range of electronic equipments developed and manufactured by the Electronics Division of GEC.

TRANSISTORISED DC AMPLIFIER by G.E.C.

For further information please write to:

THE GENERAL ELECTRIC CO LTD OF ENGLAND

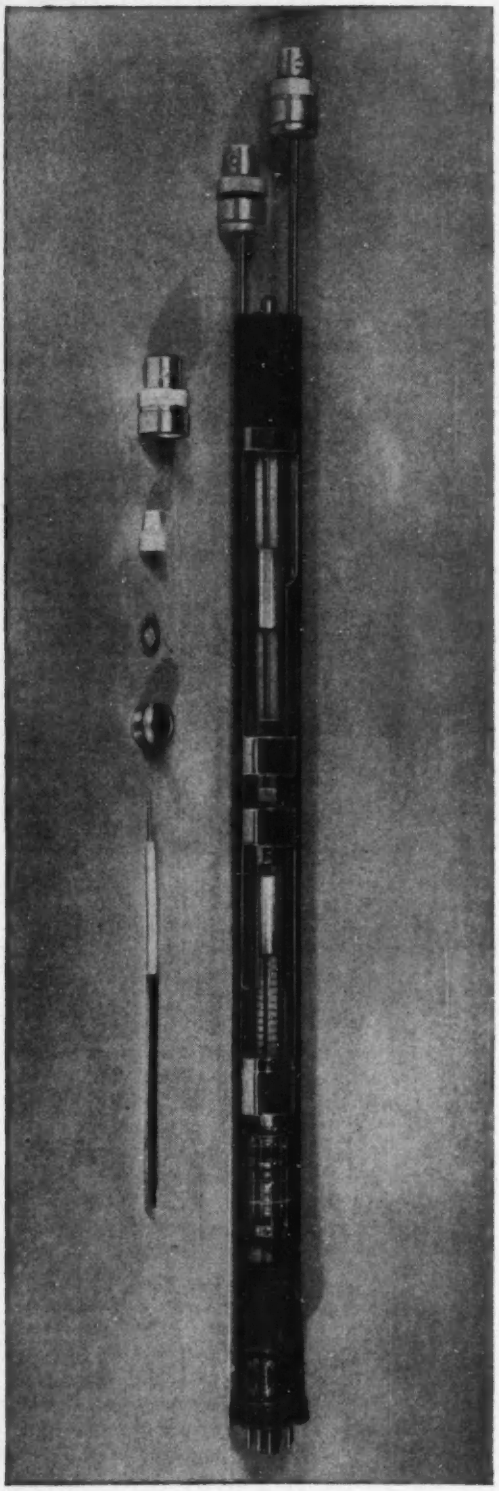
Electronics Division, Lower Ford Street, Coventry, England

EE 36 124 *for further details*

'FLUON' INCREASES PRODUCTION EFFICIENCY IN INDUSTRY

English Electric Valve Co. Ltd. use 'Fluon' components in travelling wave tube for radio link equipment

Because it is the best of the solid dielectrics, having a very low permittivity and power factor, and is an excellent electrical insulator, 'Fluon' p.t.f.e. is used for components in the travelling wave tube, made by English Electric Valve Co. Ltd., Chelmsford, for radio link equipment.
One of the most important outlets of 'Fluon' is in the electrical and electronics industries. It is being used in a wide variety of ways ranging from cable and wire insulation to TV antennae insulators; from a high temperature condenser dielectric to low friction bearings for variable resistors.
Apart from its excellent electrical properties, 'Fluon' has many other advantages. It has a remarkable working temperature range from +250°C. down to liquid nitrogen temperatures. It is tough yet flexible, and has good impact strength. It is chemically inert and has a non-stick surface which is self-lubricating.



'FLUON'

'Fluon' is the registered trade mark for the polytetrafluoroethylene manufactured by I.C.I.

'Fluon' components in travelling wave tube made by English Electric Valve Co. Ltd., Chelmsford.

ICI IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S.W.1

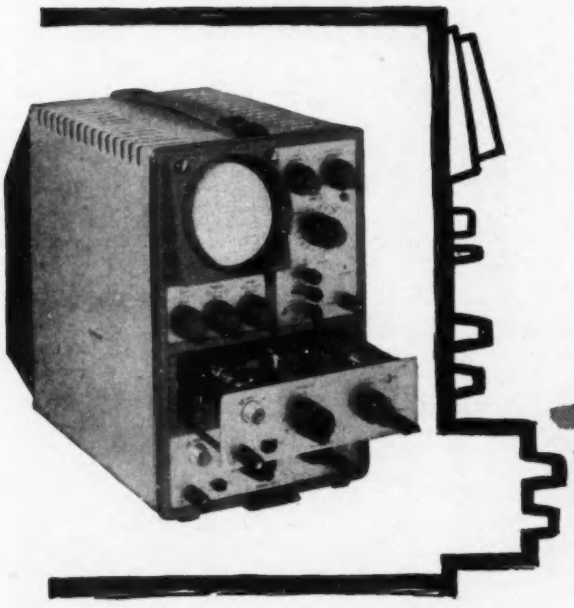
D 33 is more than a new oscilloscope... it is a new oscilloscope system.

D 33 is built to the familiar high standards of all Serviscope equipment. A special feature is the 3½" double-beam PDA tube of advanced design, operating at 3.5 KV to give an exceptionally clear trace.

PDA TUBE

HIGH GAIN

INTERCHANGEABLE AMPLIFIERS



a

GENERAL PURPOSE AMPLIFIER
dual range
1. D.C.—6 Mc/s at 100 mV/cm.
2. D.C.—200 Kc/s at 10 mV/cm.

b

DIFFERENTIAL AMPLIFIER
Maximum sensitivity 1 mV/cm D.C.—200 Kc/s. High common-mode rejection.

c

ULTRA HIGH GAIN AMPLIFIER
Maximum sensitivity 100 uV/cm, 5 c/s to 150 Kc/s.

Amplifiers are under development for strain gauge and transducer work and for higher bandwidths (10 Mc/s).

Interchangeable plug-in Y amplifiers allow one instrument to be adapted to a wide range of applications, and still to remain compact, portable... and inexpensive. All connections are made internally as the unit slides home. All or any of the basic range of amplifiers can be supplied, or special units can be built to requirements.

D 33
double beam
SERVISCOPE*
with plug-in
amplifiers

WIDE RANGE CALIBRATED TIME BASE has 18 pre-set sweep speeds from 1 usec/cm to ½ sec/cm (or slower if necessary) and a variable control covering intermediate speeds.

VERSATILE TRIGGERING CIRCUIT allows two modes of triggering:—
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X EXPANSION CONTROL X10 DIAMETERS

NEW D.C. COUPLED FLYBACK BLANKING ensures uniform trace brightness at slow sweep speeds and complete flyback suppression.

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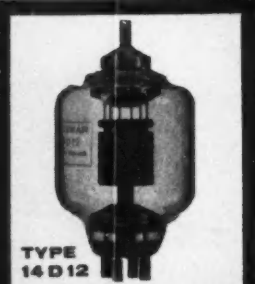
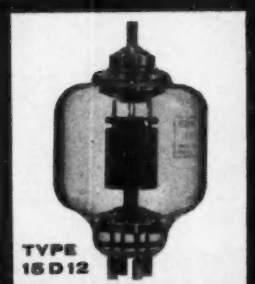
Ediswan radiation cooled triodes





TYPE	14 D 12	15 D 12
Filament voltage (volts) V_f	5·0	6·3
Filament current (amps) I_f	32·5	32·5
Maximum anode voltage (kV) $V_{a\ (max)}$	7·0	7·0
Maximum anode dissipation (W) $P_{a\ (max)}$	500·0	800·0
Mutual conductance (mA/V) g_m	3·3	5·1
Amplification factor μ	21·0	22·0
Approximate power output at full ratings (kW) P_{out}	1·5	2·5

here's why

Send for further details

AEI

Associated Electrical Industries Ltd
Radio & Electronic Components Division
Industrial Valve Department, 155 Charing Cross Road, London WC2
Tel: GERrard 9797 Telegrams: Sieswan Westcent London

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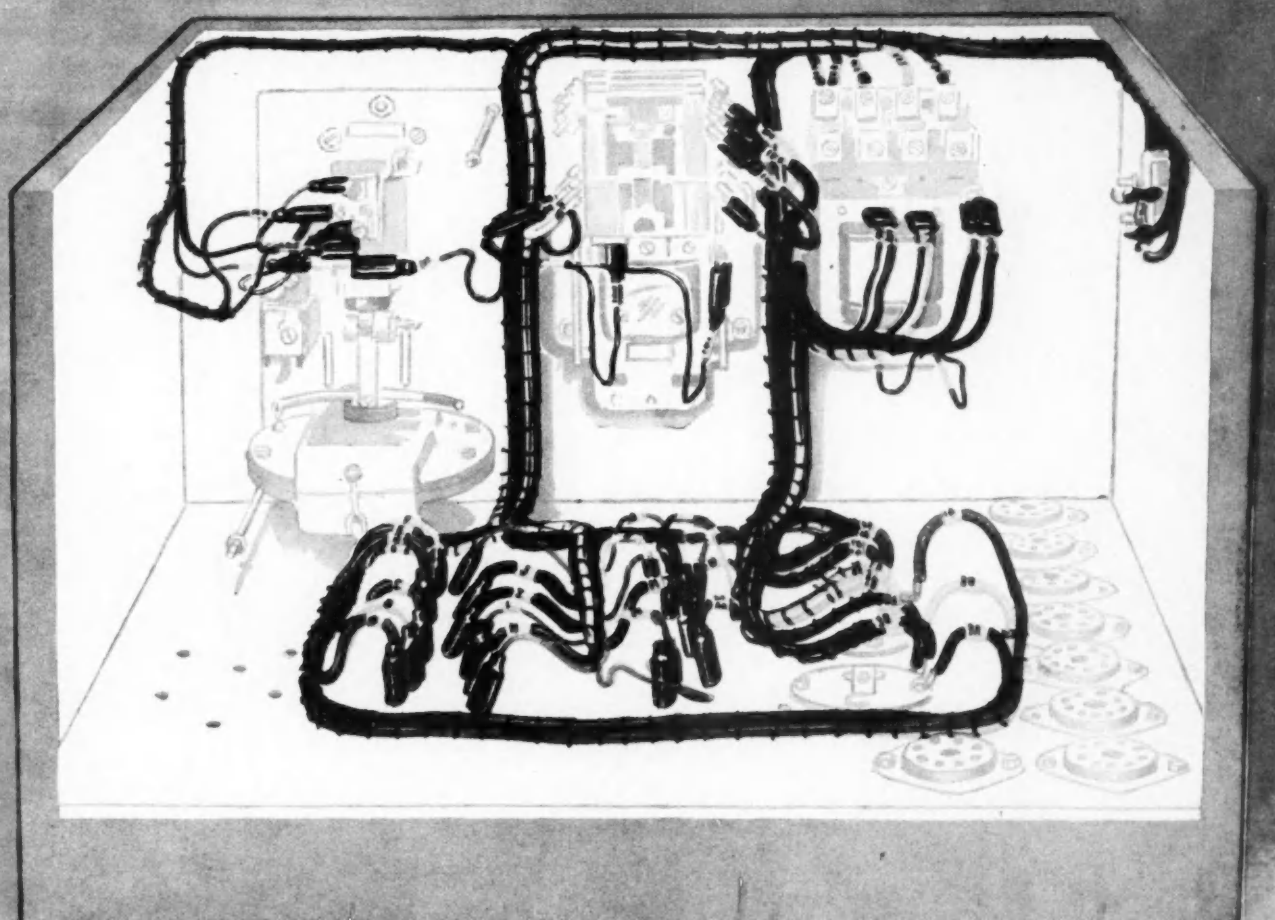

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DIRECT DIGITAL DRIVE

The difference lies here in the auxiliary anodes.

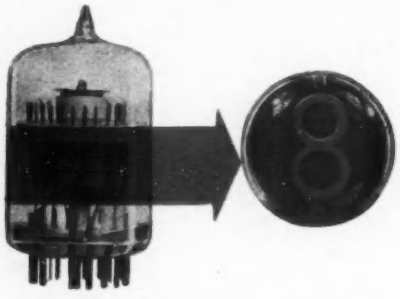
This eliminates the complex and costly switching elements necessary for digital read-out displays.

The result is an appreciable saving of money and space with upgraded circuit reliability. Specially designed to operate the end-viewing *Digitron GR.10.H. directly, this new all glass *Dekatron in addition offers the Ericsson "routing guide" facility for easy reversible counting.

PROVISIONAL DATA

Max. Counting Rate	5 kp/s
Max. Aux. Anode Current	2.0 mA
Max. Cathode Current	2.0 mA
Double Pulse Drive—Amplitude	120V
Double Pulse Drive—Duration	60 μs
Guide Bias Voltage	60V

*Registered Trade Mark



GCA 10G
DEKATRON*

GR 10H
DIGITRON*

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TUBE DIVISION
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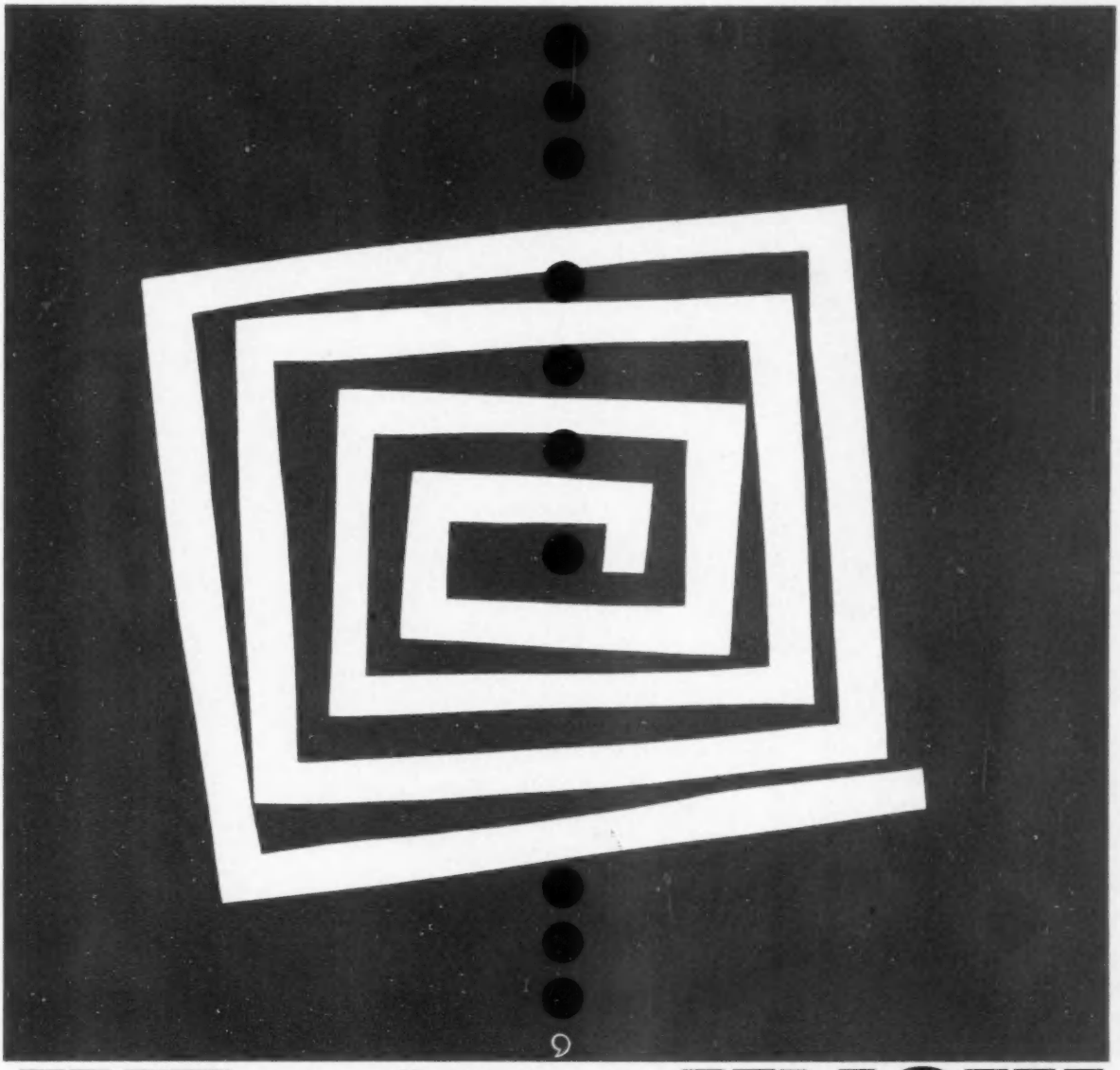

WE DON'T KNOW

. . . the pattern of glass usage in the electronics industry . . . how many different kinds of glass are used . . . what it is mostly used for . . . or all the possible applications you have for it. But we do know how to make the finest glass available, whatever your needs. If these are for optical or other technical glasses, we're experienced enough to know the right answers, and would like to hear from you.

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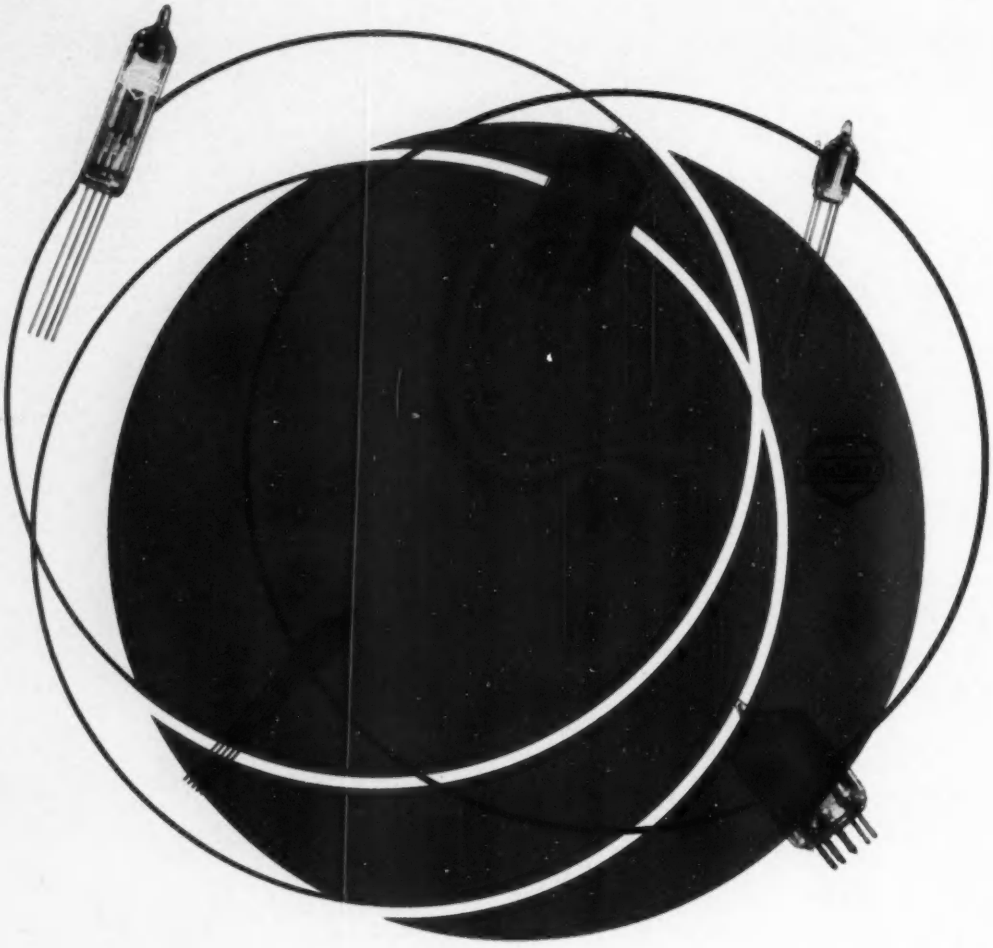

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By means of accelerated life tests carried out in our laboratories, we can now confidently predict the life expectancy of our Cold Cathode Trigger Tubes when used under predetermined conditions.

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A report describing accelerated life tests on Mullard Cold Cathode Trigger Tubes is available on request. To obtain your copy of this document, just write to Mullard quoting reference D4208.

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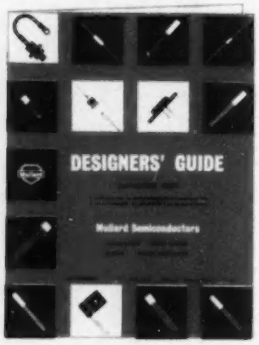
MULLARD DESIGNERS' GUIDE

a quick and easy reference for all semiconductor users



Constant research and development by Mullard on semiconductor devices could mean that your particular design problem has been solved for you. Among all the new and improved types becoming available may be just the one for which you have been searching.

You can be kept informed of up-to-date progress in semiconductors through the Mullard Designers' Guide. This extremely useful leaflet contains abridged data on every Mullard transistor, diode and rectifier recommended for new equipment designs. The information is set out for quick and easy reference and it is brought up to date every four months.

To benefit from this unique technical service, simply write to Mullard House quoting reference D328 on your business notepaper and you will be placed on the Designers' Guide mailing list.

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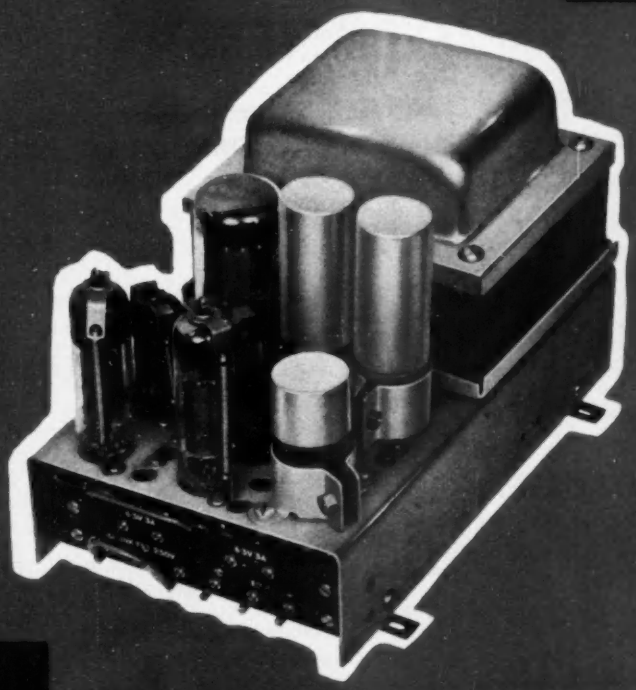
MODEL 4931



This very small unit, supplying **250** or **300 V.D.C.** at **150 mA.** max. is ideal for building into your equipment. At this price, with a stability of ±0·1% it is no longer worthwhile designing your own power pack.
Write for further details of this unit and its companion model 4964 providing 150V. or 200V. at 150 mA.

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An accurate and speedy means of measuring temperature, using Copper/Advance thermocouples of up to 350Ω resistance. Direct reading is possible due to reliable automatic cold junction compensation. Ranges 0—150°C and 0—300°C. Accuracy ± 2%. Thermocouple kit is included.

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"SCALAMP" MEGOHM-PER-VOLT D.C. VOLTMETER

A portable instrument giving all the advantages of a sensitive valve voltmeter but without zero drift. Ten ranges give full scale readings of 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V and 300V. Full scale current drain only 1 μA.

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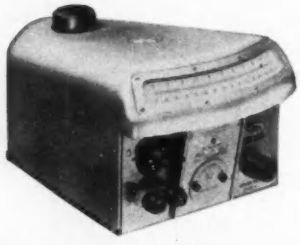

40kV ELECTROSTATIC VOLTMETER

Direct reading up to 40kV d.c. or r.m.s. a.c. regardless of waveform. Negligible leakage. Rapid response. Accuracy ± 2%.

Cat. No. 11314

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Three instruments with ranges of 1 to 5, 3 to 10 and 5 to 18kV d.c. and 1 to 5, 3 to 10 and 5 to 12kV r.m.s. a.c. Negligible leakage. Accuracy ± 2%.

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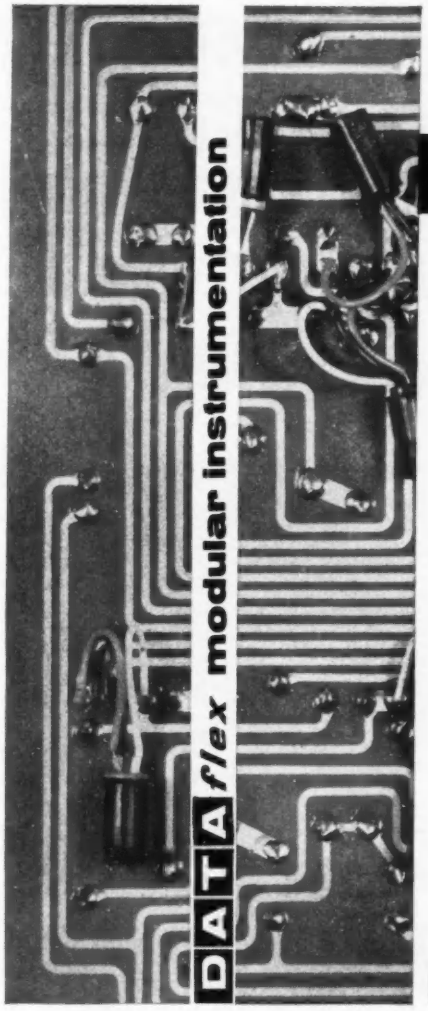
SCIENTIFIC PYE INSTRUMENTS

W. G. PYE & CO. LTD.

Granto Works, P.O. Box 60 Cambridge, England. Tel: Cambridge 58866 (5 lines). Grams: Pye, Cambridge



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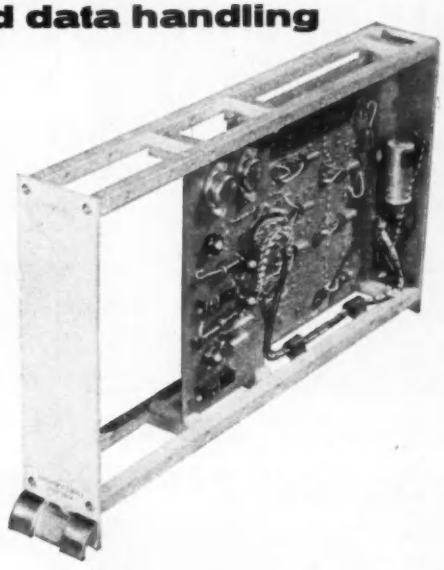
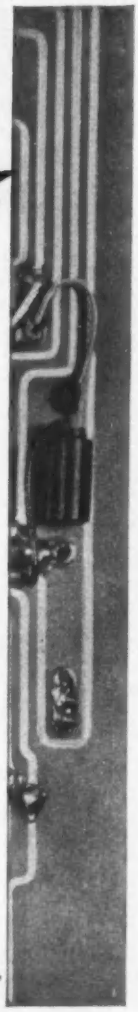
for industrial process control and data handling





REFERENCE SUPPLY

The completely transistorised Dataflex Reference Supply Type 502A provides a sub-standard negative 5 volt supply comparable with that obtainable from a standard cell. This is achieved by the use of low temperature coefficient zener diodes and a Dataflex Operational Amplifier.

The Reference Supply may be used in conjunction with Trip Amplifiers in alarm monitoring or as a calibration voltage for checking a complete measuring channel.

- **Output—5 volts at 100mA.**
- **Stability 0.1% over the range 10°C to 50°C.**
- **Output ripple less than 1mV r.m.s.**
- **Output drift less than 2mV.**
- **Voltage requirements can be supplied from the Dataflex Power Unit, type 501A.**

* *Dataflex is a Registered Trade Mark*

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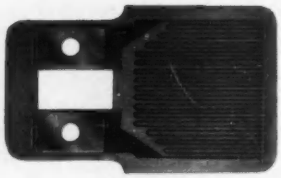
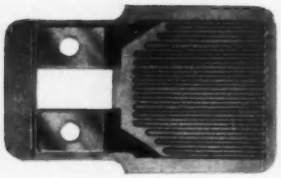
FLEXIBLE PRINTED RESISTORS

- Maximum heat dissipation in restricted space, such as contact cooled mains droppers
- Weight saving—overall thickness can be as little as .001"
- Extremely reliable
- Designed to customers' requirements





These 50 OHM printed resistors (approx. ¼ in. sq.) were developed for Joseph Lucas Ltd and are in volume production. A Mills & Rockleys patent

TGA PS2

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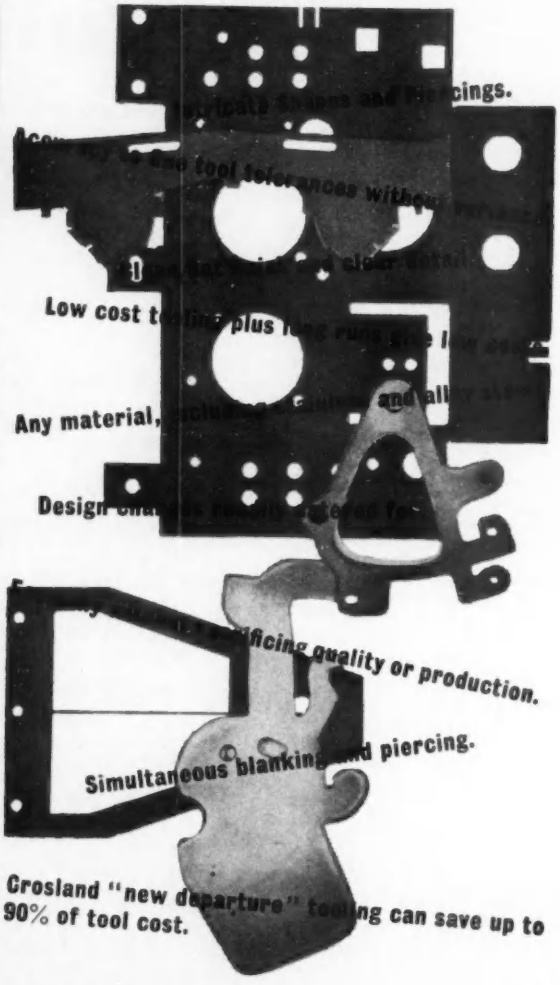

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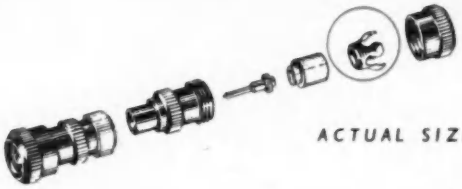
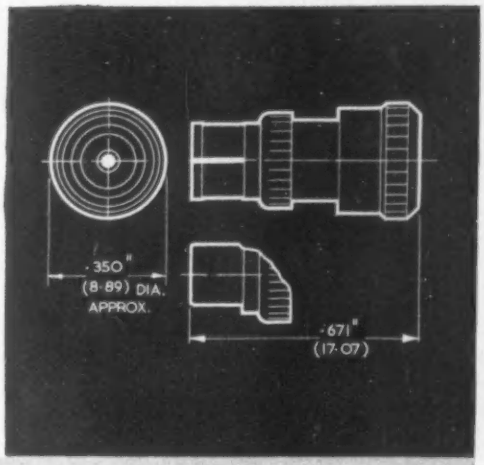
"Belling-Lee"

MINIATURE COAXIAL CONNECTOR*



ACTUAL SIZE



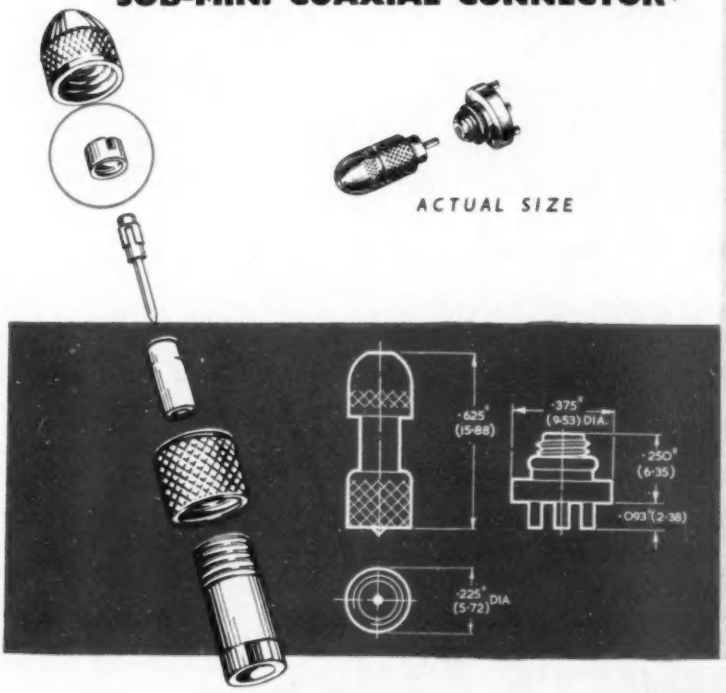
L.1465/FP. FREE PLUG
L.1465/FS. FREE SOCKET

A new miniature plug and socket, alternatives to L.1417/FP and /FS, incorporating a scaled-down version of the "tulip" cable grip (shown in the exploded view) so successfully featured in our standard range of coaxial connectors. The insulant has been changed to polythene since they are not normally required to work at very high temperatures (the centre contact is removeable for soldering), and the body of the socket is made of brass, cadmium-plated, giving improved contact efficiency at the mouth.

Despite their small size they are extremely robust, and are ideal for use in modern electronic intruments, tape recorders, car radios, etc. Fixed socket, L.1417/CS/Ag.

Working voltage:	200 V. d.c.
Breakdown voltage:	2 kV. d.c. at sea-level. 700 V. d.c. at 60,000 ft.
Voltage proof:	1.4 kV.d.c.
Insulation resistance:	Greater than 10^8 megohms.
Contact resistance:	Less than 2 milliohms.
Withdrawal force:	3-4 lbs. wt.
Max. cable size:	0.180 in. overall, 0.040 in. inner conductor.
Weight:	Plug 1.12 gm. (0.04 oz.), socket 1.17 gm. (0.04 oz.).

SUB-MIN. COAXIAL CONNECTOR*



ACTUAL SIZE

L.1403/PCS. PRINTED CIRCUIT SOCKET
L.1403/MFP. FREE PLUG

With the introduction of a fixed socket for use on printed circuit boards, a whole new field of applications is opened up for these tiny screened connectors. At the same time a new free plug has been evolved, incorporating a mechanical cable clamp which makes efficient electrical connection to the braided screen of the cable; this eliminates the tricky soldering operation which some users found objectionable with the earlier pattern.

"Belling-Lee" sub-miniature coaxial connectors are compatible with the well-known American microdot series, and their range of applications is therefore international.

Nominal impedance:	50 ohms.
Working voltage:	650 V. d.c.
Voltage proof:	1.3 kV. d.c.
Insulation resistance:	Greater than 10^8 megohms.
Contact resistance:	Less than 5 milliohms.
Screen continuity:	Less than 2.5 milliohms.
Max. cable size:	0.065 in. overall, 0.011 in. inner conductor.
Weight:	-/MFP, 1.65 gm. (0.06 oz.); -/PCS, 1.6 gm. (0.05 oz.).

Most "Belling-Lee" products are covered by patents or registered designs or applications

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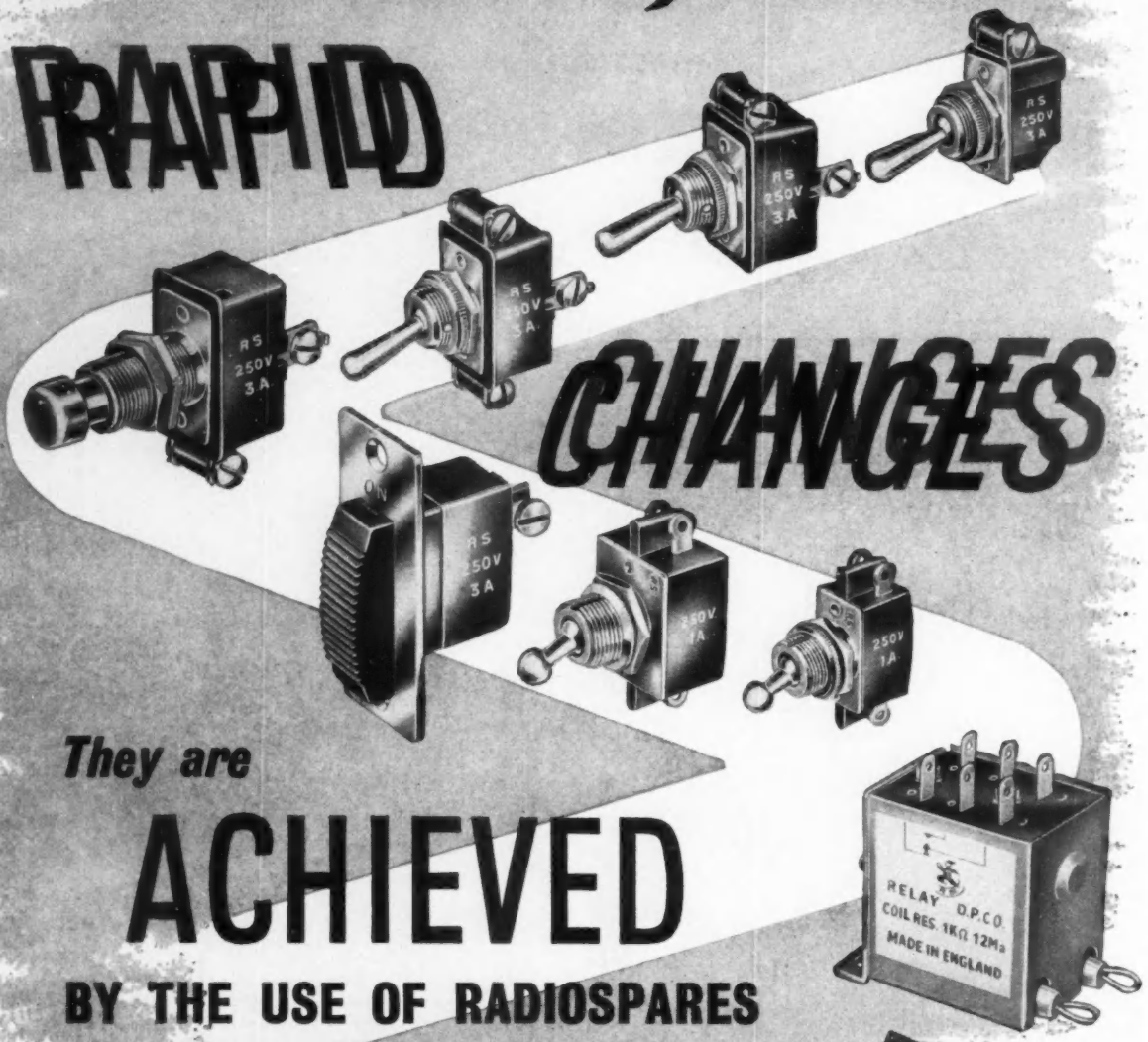

They are

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V.L.F. PHASE METER

TYPE 281

FREQUENCY RANGE: 0·01c/s to 1kc/s.

PHASE INDICATION: A reading of phase angle is obtained in one cycle by means of a brightened spot on a 6 inch C.R. tube having a circular trace and calibrated illuminated graticule.

PHASE ACCURACY: ± 2°.

AMPLITUDE MEASUREMENT: By A. C. shift technique using the built-in meter.

ACCURACY: ± 5% or ± 0·25V whichever is the greater.

INPUT REQUIRED: In addition to the unknown input, reference in-phase and quadrature signals are required. The V.L.F. Signal Generator Type 257 provides suitable outputs over the range 0·03 to 30c/s.

INPUT LEVEL: 1—300 volts peak. Measurements on signal down to 0·1 volt peak possible with reduced accuracy.

D.C. COMPONENT: Facilities are provided for cancelling out the D.C. component which may be ± 1000 volts maximum.

An L.F. Phase Meter Type 206 is also available for phase and amplitude measurements on signals up to 100kc/s.

IMMEDIATE DELIVERY—PRICE £195

FOR SERVO SYSTEM, V.L.F. NETWORK AND PROCESS CONTROL SYSTEM ANALYSIS

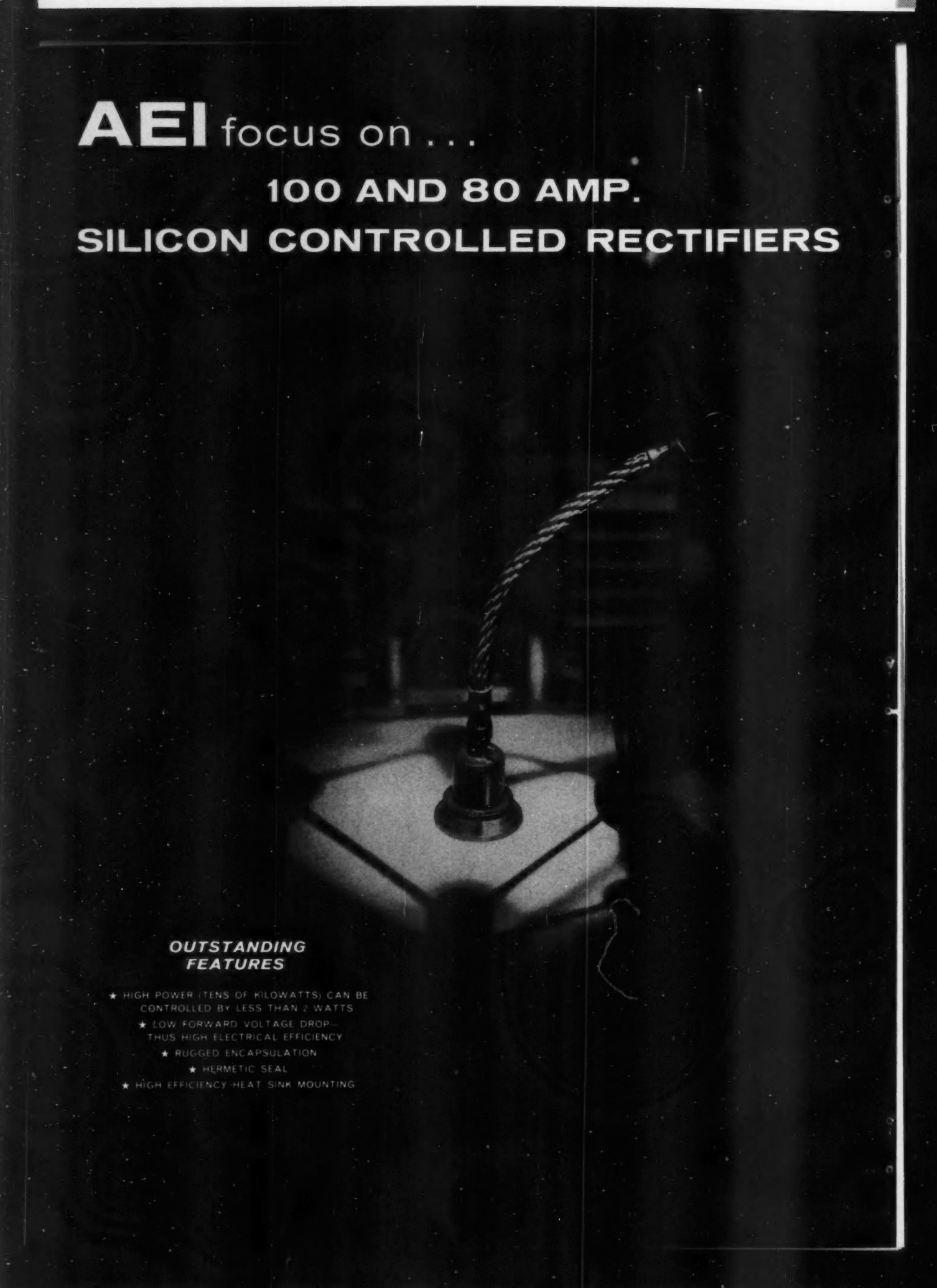
Airmec

AIRMEC LIMITED

High Wycombe, Bucks. Tel.: High Wycombe 2501/7

AEI focus on . . .

100 AND 80 AMP. SILICON CONTROLLED RECTIFIERS



OUTSTANDING FEATURES

★ HIGH POWER (TENS OF KILOWATTS) CAN BE CONTROLLED BY LESS THAN 2 WATTS

★ LOW FORWARD VOLTAGE DROP— THUS HIGH ELECTRICAL EFFICIENCY

★ RUGGED ENCAPSULATION

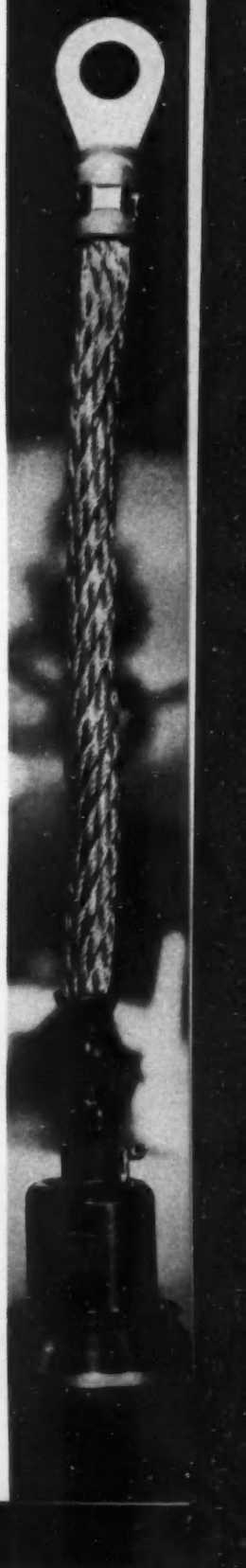
★ HERMETIC SEAL

★ HIGH EFFICIENCY HEAT SINK MOUNTING

FOR MOTOR CONTROL, HIGH POWER STATIC SWITCHING, SERVO SYSTEMS, HIGH POWER INVERTORS, AND REGULATED D.C. POWER SUPPLIES.

ADVANCE INFORMATION

100 AND 80 AMP SILICON CONTROLLED RECTIFIERS



100 AMP TYPES	CR100-	21	51	71	101	151	201	251	301
Peak Forward Working Voltage (Volts)		25	50	75	100	150	200	250	300
Peak Reverse Voltage (Volts)		25	50	75	100	150	200	250	300
Max. Mean Forward Current (Amps)*		100	100	100	100	100	100	100	100
Max. Recurrent Peak Forward Current (Amps)		500	500	500	500	500	500	500	500
Max. Forward Voltage Drop at 350 amps Peak (Volts)		2	2	2	2	2	2	2	2
Max. Trigger Firing Current Required (Amps)		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Max. Trigger Firing Voltage Required (Volts)		4	4	4	4	4	4	4	4
Max. Peak Trigger Current (Amps)		2	2	2	2	2	2	2	2
Max. Mean Trigger Current (Amps)		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Peak Forward Trigger Voltage —anode + ve (Volts)		10	10	10	10	10	10	10	10
Peak Forward Trigger Voltage —anode —ve (Volts)		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Peak Reverse Trigger Voltage		5	5	5	5	5	5	5	5

80 AMP TYPES	CR80-	21	51	71	101	151	201	251	301
Peak Forward Working Voltage (Volts)		25	50	75	100	150	200	250	300
Peak Reverse Voltage (Volts)		25	50	75	100	150	200	250	300
Max. Mean Forward Current (Amps)*		80	80	80	80	80	80	80	80
Max. Recurrent Peak Forward Current (Amps)		500	500	500	500	500	500	500	500
Max. Forward Voltage Drop at 350 Amps Peak (Volts)		2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Max. Trigger Firing Current Required (Amps)		0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Max. Trigger Firing Voltage Required (Volts)		4	4	4	4	4	4	4	4
Max. Peak Trigger Current (Amps)		2	2	2	2	2	2	2	2
Max. Mean Trigger Current (Amps)		0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Peak Forward Trigger Voltage – anode + ve (Volts)		10	10	10	10	10	10	10	10
Peak Forward Trigger Voltage – anode – ve (Volts)		0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Peak Reverse Trigger Voltage		5	5	5	5	5	5	5	5

*At a conduction angle of 180° and base temperature of 50°C.

Frequency: The ratings given apply without derating to sine wave operation up to 3 Kc/s.

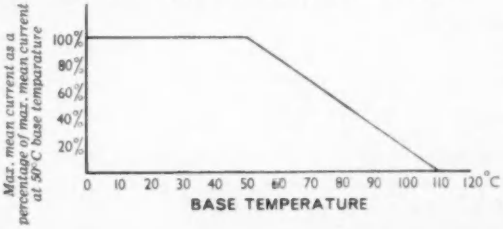
Temperature: The provisional curve for derating with temperature is shown below.

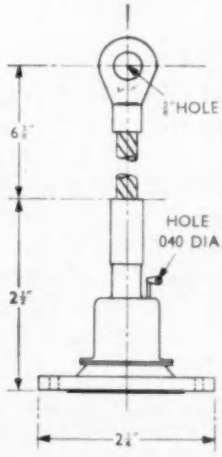
FEATURES

Encapsulation All AEI Silicon Controlled Rectifiers are hermetically sealed in metal glass enclosures backfilled with dry inert gas to ensure long life in all environments.

Mounting The CR100 and CR80 are mounted on a substantial nickel plated copper base providing efficient thermal and electrical contact. A fixing ring is provided with each controlled rectifier.

Dimensions for all types are as shown on the right.


Max. mean current as a percentage of max. mean current at 50°C base temperature
100%
80%
60%
40%
20%
0 10 20 30 40 50 60 70 80 90 100 110 120°C
BASE TEMPERATURE



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Others will want to see it. If you would like to have full details of these or any other AEI electronic components for that matter, all you have to do is write to AEI at the address below. Data sheets with detailed information will be sent to you without charge.

DON'T DELAY—*write now and be sure of receiving latest news of these and other AEI components as they become available.*

AEI **Associated Electrical Industries Limited**

ELECTRONIC APPARATUS DIVISION, VALVE & SEMI CONDUCTOR SALES DEPT.
CARHOLME ROAD · LINCOLN · TEL: LINCOLN 26435

A5671

"Remember Wings Day, September 16th, and give generously for those who gave".

EE 36 143 *for further details*

DOWN *with* *mains* *rectification* COSTS

The Mullard BYY15 Silicon Power Rectifier offers:

* Direct rectification of the mains
* High reliability factors
* Space savings
* PLUS lower costs

For the direct rectification of 250V mains, with full voltage tolerance, the Mullard BYY15, a 20A, 400V silicon power rectifier, offers high performance and reliability at a really economical price.

It can be used in series or parallel combinations for output currents of more than 20A and still show an appreciable saving over rectifiers with higher current ratings. From a 250V supply a single phase bridge of four BYY15's gives an output current of 40A and a three phase bridge of six BYY15's gives 60A.

For full data on the BYY15, please write to the address below quoting reference D 358.

Mullard
semiconductors for industry

MULLARD LIMITED *Semiconductor Division*
Mullard House Torrington Place London WC1
Telephone Langham 6633

MIS 35

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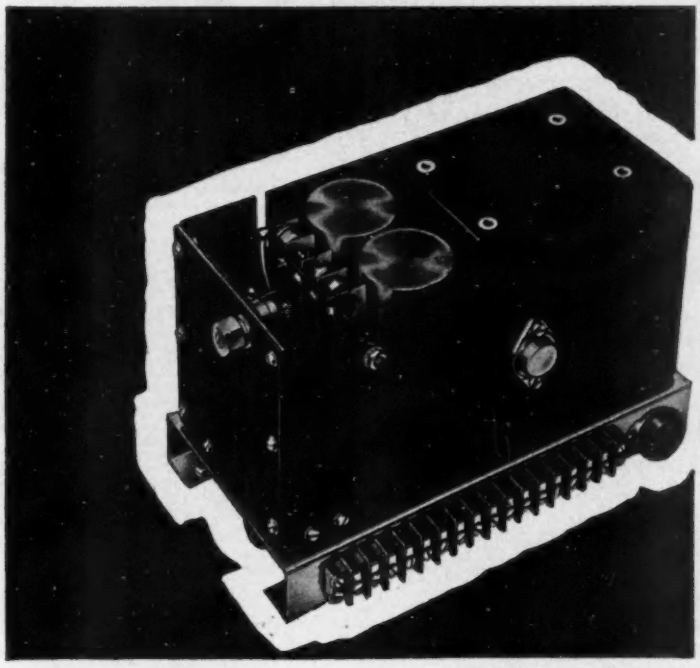
CHOOSE BELIX



CHOOSE BELIX TRANSISTOR POWER SUB-UNITS

THE BELIX COMPANY LIMITED • VICTORIA ROAD SURBITON SURREY • ELM 9118

TYPE No.	TSS 61	TSS 62	TSS 63	TSS 300	TSS 04	TSS 14	TSS 24	TSS 34	TSS 44	TSS 241	TSS 114	TSS 104	TSS 94	TSS 84	TSS 74	TSS 121	TSS 122	TSS 123	TSS 124	TSS 125	TSS 51	TSS 52	TSS 53	TSS 54	TSS 55
OUTPUT *d.c. volts:*	0-12	0-12	0-12	0-24 ▫	0-6	6-14	12-20	16-24	20-30	0-24 *	0-6	6 14	12-20	16-24	22-30	0-6	6-12	12-20	16-24	20-30	0-6	6-12	12-20	16-24	20-30
OUTPUT *amps (max.):*	0·1	0·3	0·5	1·0	1·0	1·0	1·0	1·0	1·0	1·0	2·0	2·0	2·0	2·0	2·0	6·0	6·0	6·0	6·0	6·0	10·0	10·0	10·0	10·0	10·0
STABILITY RATIO *(7% mains)*	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1	1000 : 1
SOURCE RESISTANCE Ω *less than:*	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0 01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01	0·01
A.C. IMPEDANCE Ω *(max.) to 200 kc/s:*	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15	0·15
RIPPLE *(pk-pk) mV less than:*	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0

* *Provides two independent outputs.* ▫ *Available as plug-in or wire-in sub-unit. TSS 61, 62, 63 are continuously variable; all other units have coarse step plus fine adjust facility.*

belix

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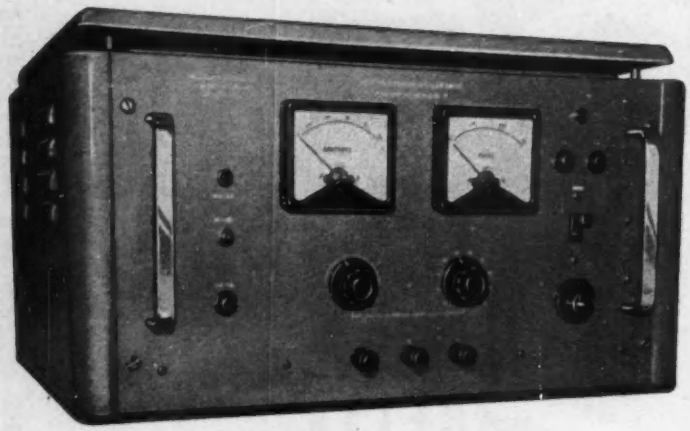
PRECISION WORKMANSHIP

is the Keynote . . .



0 TO 30 VOLTS D.C.

AT 10 AMPS. FULLY REGULATED

Output resistance:	0.01 ohm.
Stabilisation:	1000 : 1
Ripple:	1mV. peak to peak
Mains Supply:	200/250 v. 50 c/s

OVERLOAD CUT-OUT.

FULLY FLOATING OUTPUT TERMINALS.

SILICON AND GERMANIUM DEVICES USED THROUGHOUT.

TRANSISTOR POWER SUPPLY
TYPE KTV/310

OTHER TRANSISTOR
POWER SUPPLIES AVAILABLE

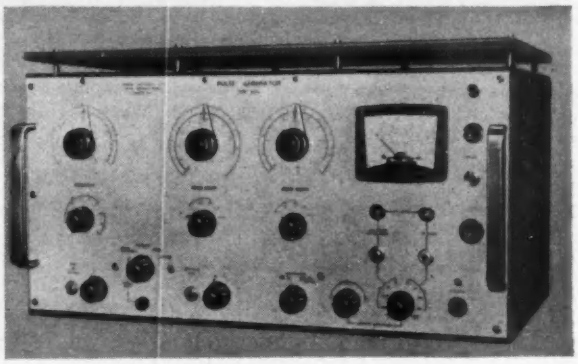
PULSE GENERATOR

TYPE 302A

GENERAL PURPOSE

LABORATORY INSTRUMENT

½ amp. peak current available in output 0 to 100 volts continuously variable output. Fully Regulated Internal D.C. supplies. Rise Times of 0.015 μS. Low output impedance. Extremely small jitter.



SPECIFICATION:

Oscillator frequency:	10 c/s to 1 Mc/s.
Delay:	0.3μs. to 10 ms.
Pulse Width:	0.1μs. to 10 ms.
Pulse amplitude: (positive or negative)	0 to 30 volts into 75 ohms. 0 to 100 volts into 1,000 ohms.
Square waves:	10 c/s to 1 Mc/s.

The instrument can be synchronized or triggered from an external source.

Also available

OSCILLOSCOPES
DOUBLE PULSE GENERATOR
TRANSISTOR ANALYSER
STABILIZED POWER SUPPLIES
both high voltage and low voltage giving output currents of 50 mA. to 10 amps.

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Telephone: ARChway 6160

SKM

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INSTALL FIRST SMALL DIAMETER COAXIAL CABLE TELEPHONE SYSTEM

Testing a Repeater in Sardinia

SARDINIA

ONE OF 17 COUNTRIES HAVING STC COAXIAL SYSTEMS

STC with their Associate Company in Italy have supplied to the Italian telephone administration, the world's first small diameter coaxial cable line equipment to carry commercial telephone traffic. It can provide up to 300 speech circuits between Golfo degli Aranci and Cagliari. The route, 226 miles (363 km) approximately, includes terminal repeaters, main repeaters and 99 all-transistor dependent repeaters. The dependent repeaters are installed in housings buried below ground. STC are also supplying: Supervisory and alarm equipment, all-transistor transmission test equipment, and no-break amplifier change-over equipment.

The wealth of experience, gained since 1935 when STC produced the first long distance coaxial cable in Great Britain, has made STC and their Associated companies the foremost manufacturers of coaxial cable transmission equipment in Europe.

STC COMMUNICATIONS GROUP

61/IC

Standard Telephones and Cables Limited

TRANSMISSION DIVISION · NORTH WOOLWICH · LONDON · E.16

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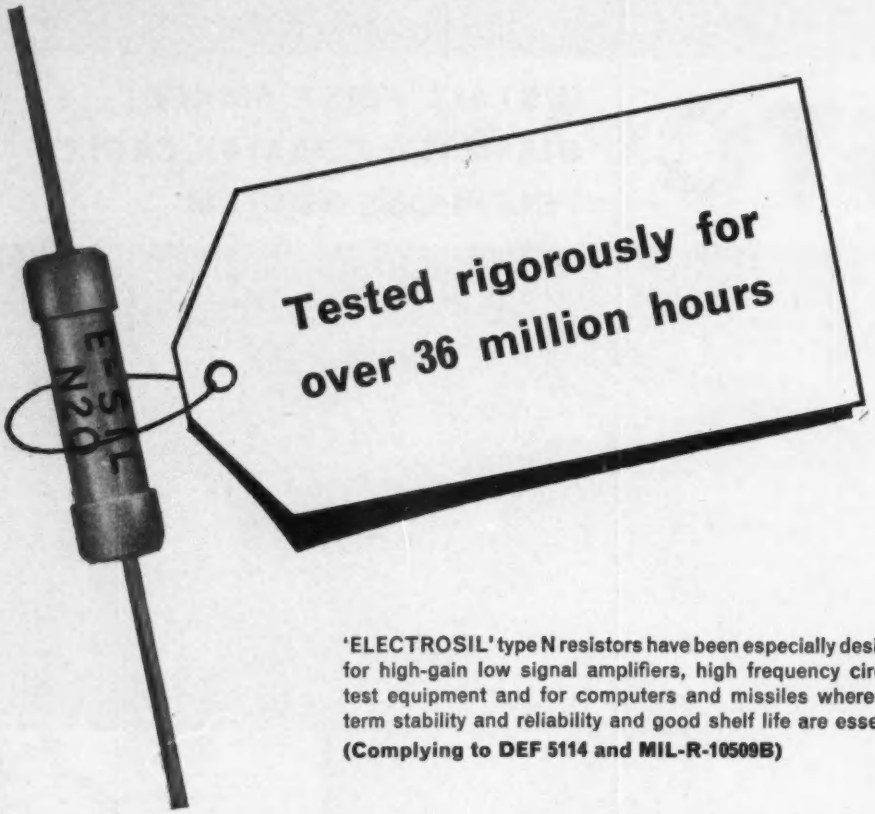

'ELECTROSIL' type N resistors have been especially designed for high-gain low signal amplifiers, high frequency circuits, test equipment and for computers and missiles where long term stability and reliability and good shelf life are essential. (Complying to DEF 5114 and MIL-R-10509B)

Unique construction 'Electrosil' metal oxide resistors are made by bonding a rugged metallic oxide film into the skin of 'Pyrex' glass rod at red heat. This film is robust, impervious to moisture, unaffected by the heat of soldering and even more abrasion-resistant than the surface of the glass base.

Extensive life-testing was carried out on 1,500 type N20 resistors over a period of 3½ years at loading up to 140% of rated wattage. During this period, groups of the resistors were also exposed to multiple power stresses along with temperature fluctuations, humidity and dust.

PERFORMANCE UNDER 3½-YEAR TEST

Proved long-term stability: Over the 3½-year test, resistance change less than 1%. No catastrophic failure.

Proved reliability Assuming a ±3% resistance change as the criterion of failure, the resistors demonstrated less than 0.000083 failures per 1,000 hours of operation. There were no catastrophic failures, but if one were assumed at the end of the tests, this failure rate is less than .000028 per 1,000 hours of testing.

'Electrosil' components for the electronics and allied industries include a most comprehensive range of metal oxide film resistors from miniature ⅛ watt to large power types; precision glass fixed and trimmer capacitors; 'Multiform' for glass/metal seals: and 'Fotoceram' for printed circuit boards. Further information—please send for catalogue.

Electrosil Regd. Trade Mark METAL OXIDE FILM RESISTORS

Electrosil Limited, Coinbrook By-Pass, Coinbrook, Slough, Bucks.

Controlled by James A. Jobling & Co. Ltd. and the Corning Glass Works of Canada

Telephone: Coinbrook 2306 Telegrams: Esil

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STC
midget and sub-miniature relays

NOTE THESE FEATURES

MIDGET RELAYS

Small size
Light weight
Services approved
Sealed or open versions
Six coil voltages
Light, medium or heavy duty contacts

SUB-MINIATURE RELAYS

Extra small size
Weight only 12.5 grammes
Ideal for transistorized and printed circuits
Gold alloy contacts for reliability
Three coil voltages
Type approved by R.C.S.C.

STC Midget and Sub-miniature Relays are designed to give the highest possible reliability under exacting conditions of service. They are robust, light in weight and extremely small. Introduced originally for use in aircraft radio equipment, they have proved of great utility in a wide variety of applications.

Ask for Data Sheets E/185 and E/311

STC COMMUNICATIONS GROUP

61/14c

Standard Telephones and Cables Limited

RADIO SYSTEMS DIVISION: OAKLEIGH ROAD · NEW SOUTHGATE · LONDON N.11

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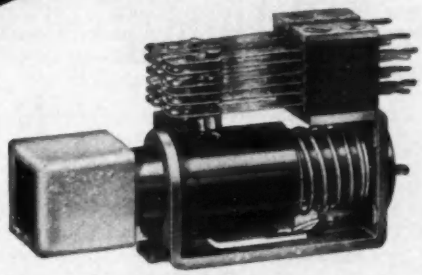
* another achievement by TMC

illuminated PUSH BUTTON KEYS with these OUTSTANDING FEATURES

advanced design high performance low price



Actual size 2½" x 1½"

TMC's new, neat and compact push-button keys, with built in lamp, possess the precision and dependability that electronic, computer and communication engineers demand. Yet the keys have been so designed that this high quality can be provided at a surprisingly low price. *For example the 4 changeover, non-lock model* illustrated costs about 15/-.

- **Locking, non-locking or inter-locking models available from stock.**
- **Suitable for *any* control application. Replaces ordinary lever type keys and separate lamps.**
- **2 or 4 changeover actions.**
- **Twin silver contacts—100V at 300mA max.**
- **Long life nylon body with precision locking track.**
- **Offered with or without telephone type lamp.**
- **Instant lamp replacement.**
- **Push buttons (round or rectangular) in black or white with a range of 5 coloured lenses.**
- **Multi-way mounting plates for panel or chassis fixing.**

Deliveries commence September, 1961 from large stock but advance orders are heavy so place yours now to avoid delay. If you require further details of the range and prices write immediately to:—

TELEPHONE MANUFACTURING COMPANY LIMITED

Dept. B Martell Road, West Dulwich, LONDON SE21 *Telephone:* GIPsy Hill 2211

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TMC

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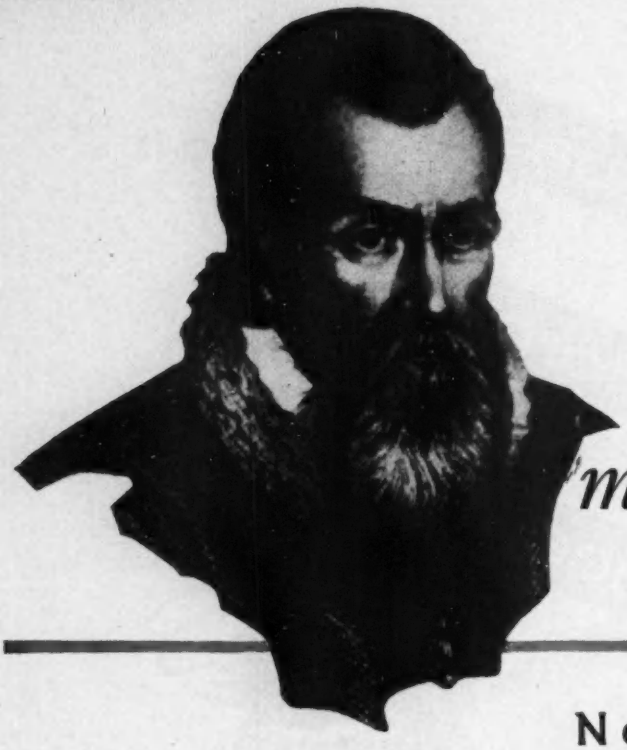
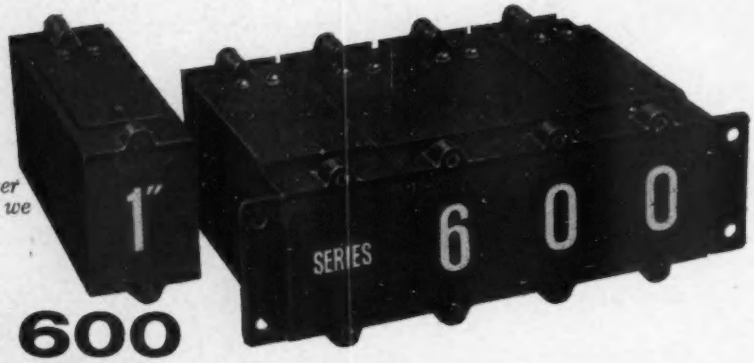


a calculation of mathematicians

No. 3 NAPIER

Napier studied at St. Andrews, St. Pancras and all points east. He was educated in Paris. In 1614 he discovered logs. Unlike Archimedes, in a somewhat similar situation (and a bath) there is no record of his running through the streets shouting "Timber". This was because Napier was a Scot and therefore dour. Napier's original Log Tables contained no explanation of how they were calculated which may seem like cheating. Napier explained however, that he was just trying the Log on the dog. Actually, his Logs were welcomed by all except Jones Minor and were blessed (in triplicate) by the Ministry of Fuel and Power. The use of Logs has the great advantage of cutting out multiplication and division. The use of a C.I. machine has the further advantage of cutting out addition and subtraction as well.

And the use of a C.I. Series 600 in-line Digital Display has the extra, further advantage of enabling you to read the final result from a safe distance. Clear characters, uniform in size and density are projected on to a flat, continuous surface—they're quicker to read than falling off a log! And we can't say fairer than that.



series 600
IN-LINE DIGITAL DISPLAY

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AEI focus on...

MINIATURE ZENER DIODES

For COMPUTERS, DATA PROCESSING, INSTRUMENTATION, CLIPPING CIRCUITS, GENERAL VOLTAGE LIMITING and similar applications.

ADVANCE INFORMATION

OUTSTANDING FEATURES

★LOW CURRENT DRAIN ★SMALL SIZE AND LOW WEIGHT ★PREFERRED VOLTAGE TYPES ★DOUBLE-ENDED ALL-GLASS CONSTRUCTION ★HERMETIC SEAL

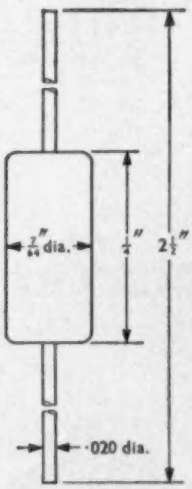
Features—common to all these AEI Miniature Zener Diode Types

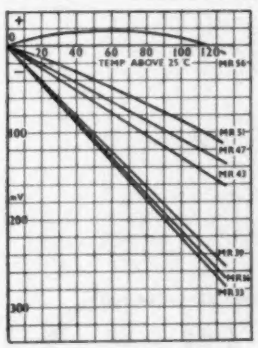
All glass encapsulation with sub-miniature construction . . . Hermetic sealing enables these diodes to be used in a wide range of environmental conditions . . . Rigidity of assembly and small size enable all types to withstand severe mechanical vibration and shock.

Diode Type	Zener voltage at 5 mA 25°C			Dynamic Slope resistance at 5 mA 25°C		Leakage current at 2V 100°C		Maximum Continuous Reverse current at 25°C mA
	Min. V	Typ. V	Max. V	Typ. Ohm	Max. Ohm	Typ. µA	Max. µA	
MR 33 H	3·1	3·3	3·5	90	100	250	600	50
MR 36 H	3·4	3·6	3·8	86	95	80	200	47
MR 39 H	3·7	3·9	4·1	80	90	35	100	44
MR 43 H	4·0	4·3	4·5	72	85	13	50	42
MR 47 H	4·4	4·7	5·0	62	80	3·0	30	40
MR 51 H	4·8	5·1	5·4	50	70	1·0	30	38
MR 56 H	5·3	5·6	6·0	28	50	0·6	10	35
MR 62 H	5·8	6·2	6·6	10	30	0·4	10	33
MR 68 H	6·4	6·8	7·2	3·7	15	0·85	10	29
MR 75 H	7·1	7·5	7·9	4·0	15	1·25	10	27
MR 82 H	7·7	8·2	8·7	5·5	20	1·5	10	25
MR 91 H	8·6	9·1	9·6	8·0	20	2·0	10	23
MR 100 H	9·4	10·0	10·6	11·0	30	2·0	10	21

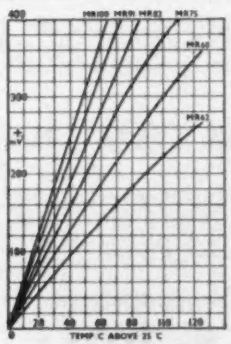
	Forward volt Drop at 5 mA			Typical forward Slope resistance at 5 mA	Capacitance at −2 volts			Maximum Continuous forward current at 25°C mA
	Min. V	Typ. V	Max. V	ohms	Min. pF	Typ. pF	Max. pF	
All above types	0·67	0·71	0·73	6·3	100	275	700	225

DIMENSIONS similar for all types





Typical change in reference voltage at 5 mA with temperature



Typical change in reference voltage at 5 mA with temperature

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—others will want to see it . . . If you would like to receive full details of these or any other AEI electronic components, all you have to do is write to AEI at the address below. Data sheets with detailed information will be sent to you without charge.

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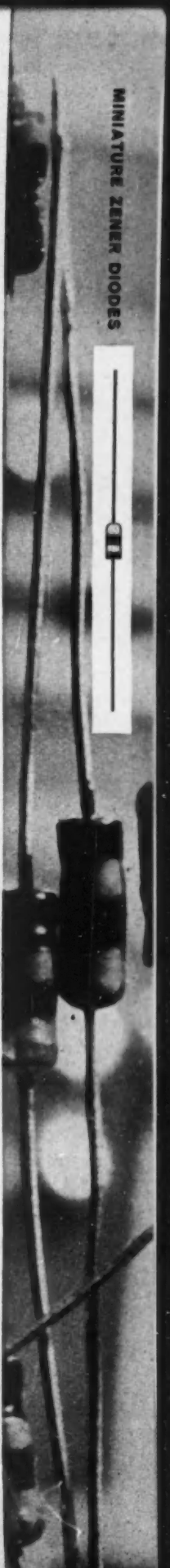
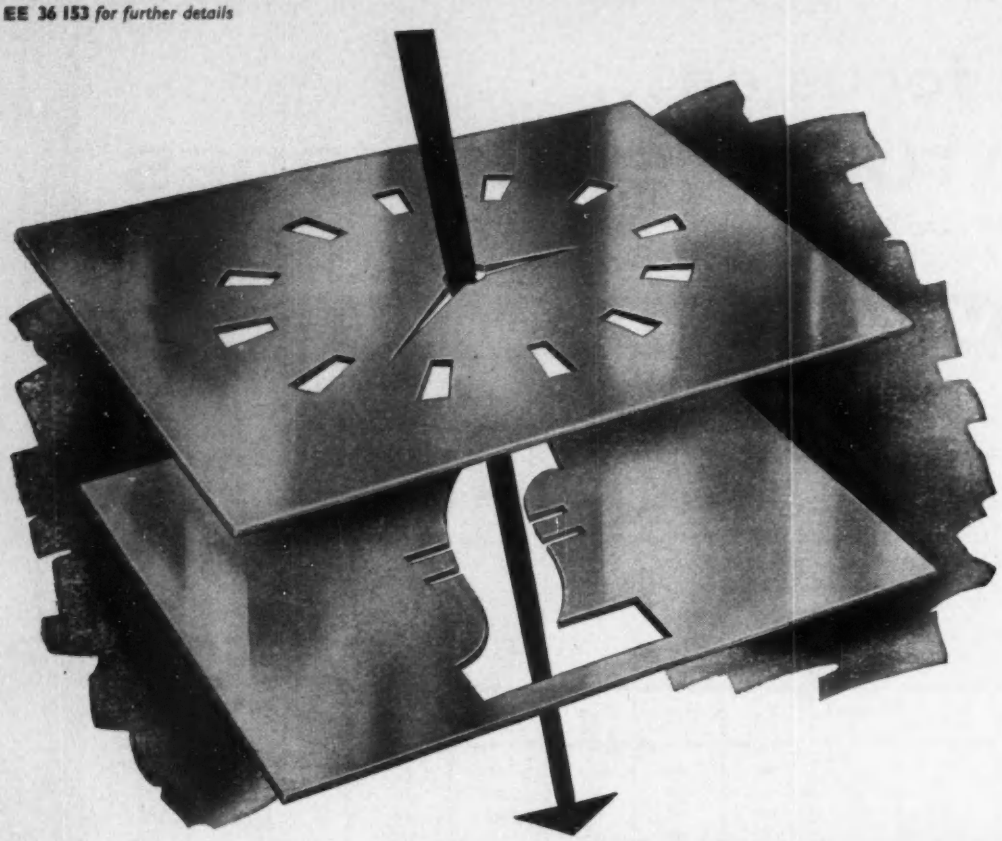
A9/13

"Remember Wings Day, September 16th, and give generously for those who gave".



EE 36 153 *for further details*



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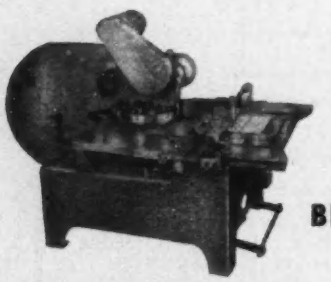

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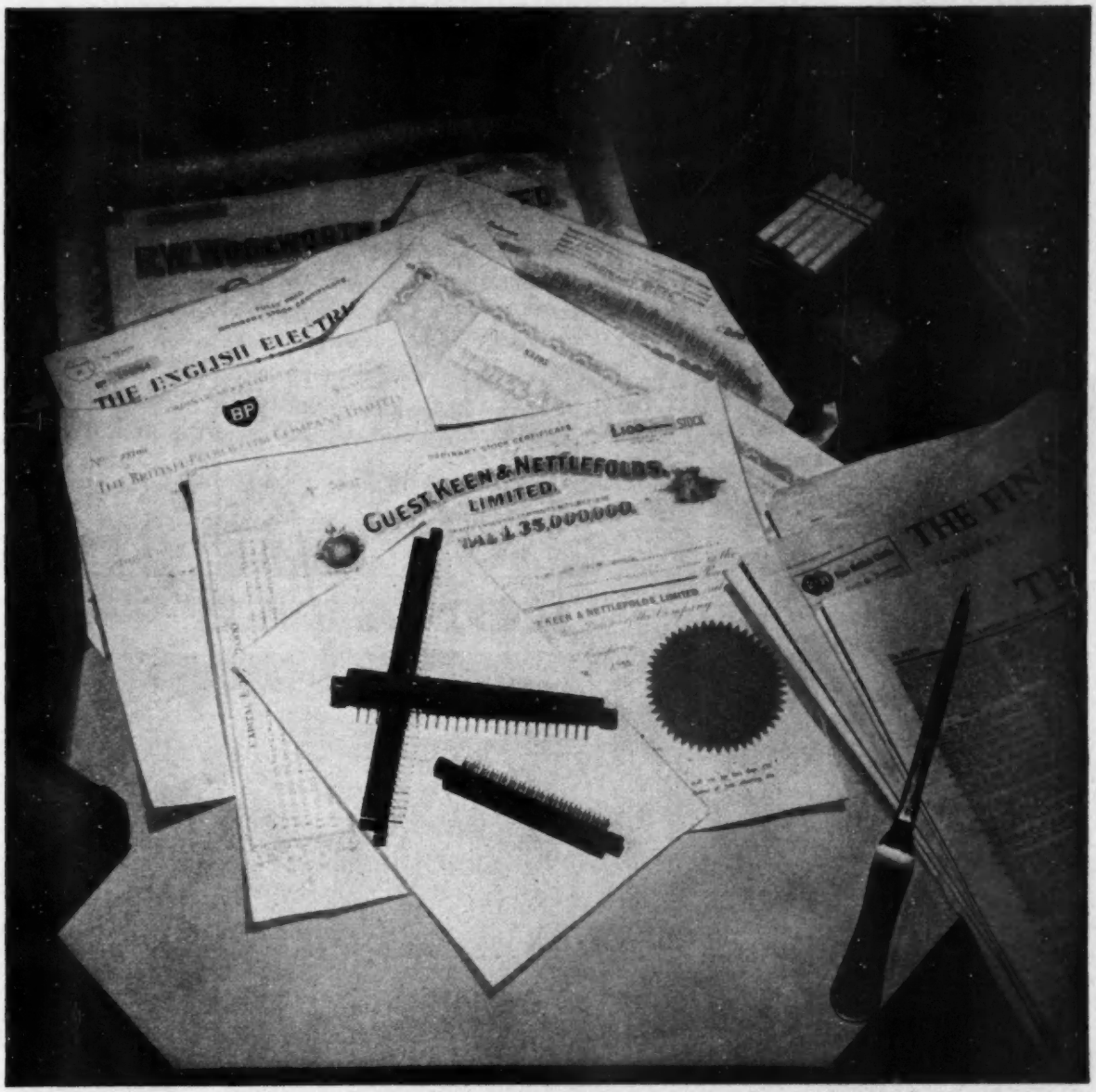

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SINGLE-SIDED BOARDS			DOUBLE-SIDED BOARDS		
Contact pitch	*Board thickness*	*Number of ways*	*Contact pitch*	*Board thickness*	*Number of ways*
0.100	0.062	8, 16, 24 & 32	0·150	0.062	16, 32, 48, 64 & 80
0.150	0.062	8, 16, 24, 32 & 40	0.200	0.062	16, 32, 48 & 64
0.156	0.062	6, 10, 12, 15, 18, 22 & 27	0.200	0.093	48 & 56
0.200	0.062	4, 8, 12 & 16 (0.100 with alternate contact omitted)	*Many other types are available*		
			SPECIAL DESIGN		
			0.150	0.062	108/32 single-sided & 20 double-sided
0.200	0.062	8, 19, 24 & 32			
0.200	0.093	24 & 28	0.156	0.062	36 ways double

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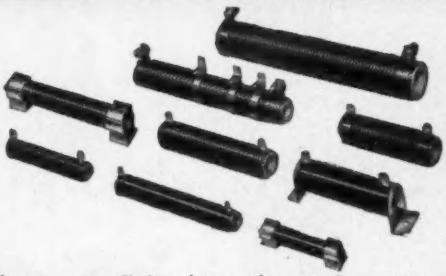
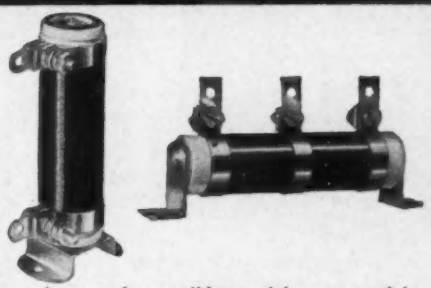


Vitreous enamelled resistors wire-wound or corrugated edge-wound tape on ceramic core. Withstand severe vibration and thermal shock. 6 to 220 watts rating.



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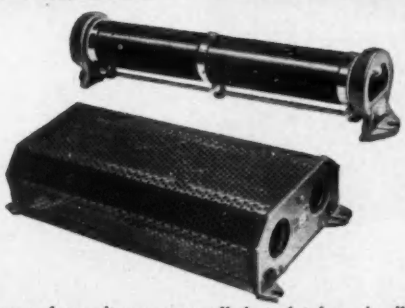

Wire-wound on vitreous enamelled steel tubes. Available with welded fixing lugs or plated steel covers. Single or double tube models up to 14,500 ohms.

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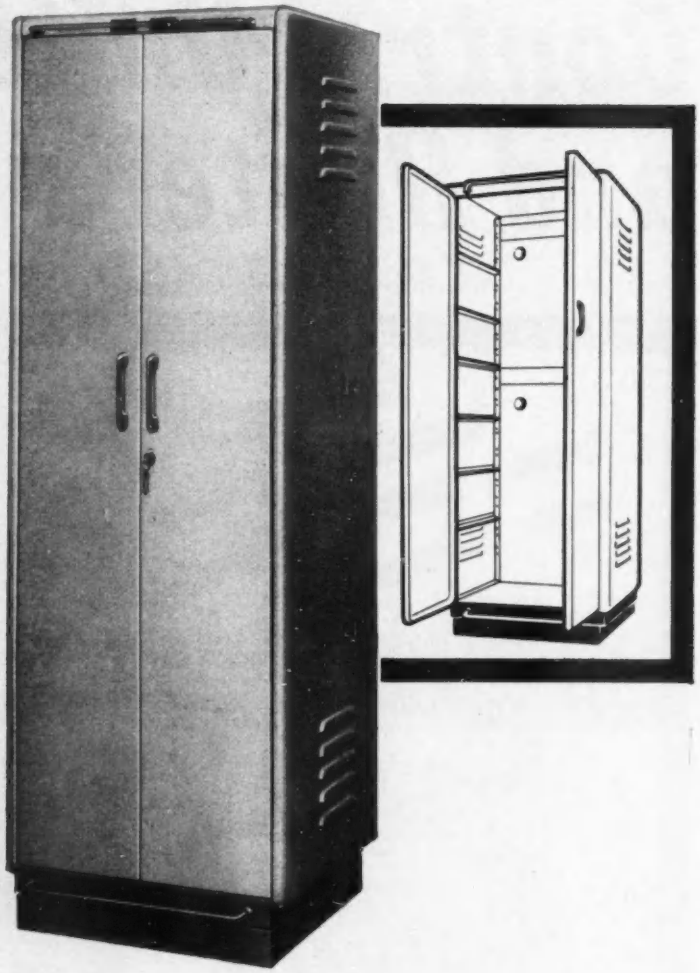

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* Hinged sides giving access to equipment for ease of servicing.
* Sides removable to enable bolting of cabinets together for assembly into bays of any length.
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* Mounting is for standard 19″ Post Office type panels.

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DEPTH	24.5/8″
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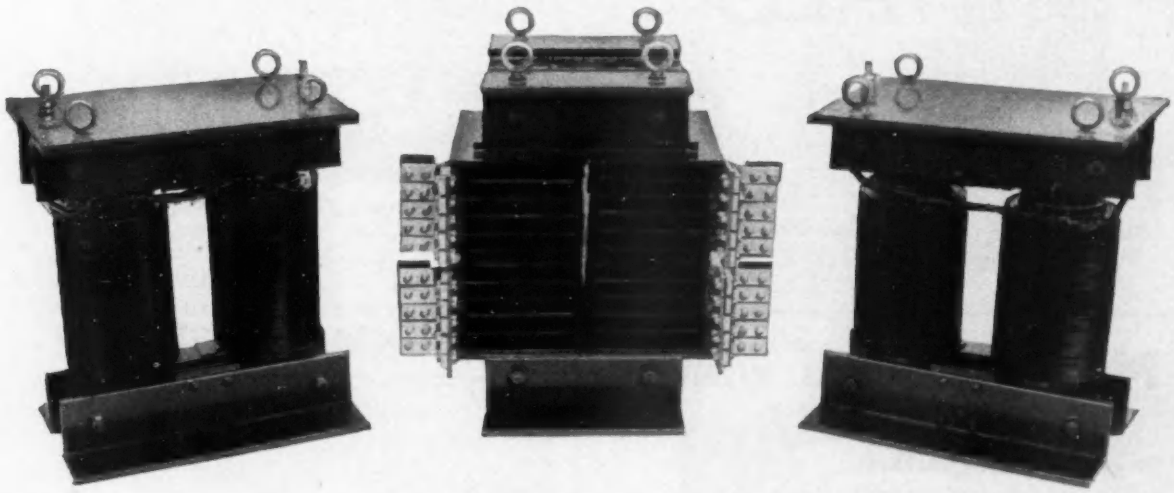

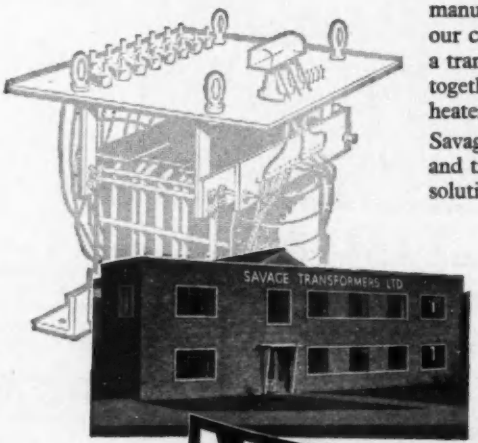

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Savage manufacture many different types of transductors and transformers and are always pleased to help with the solution of any new problem.

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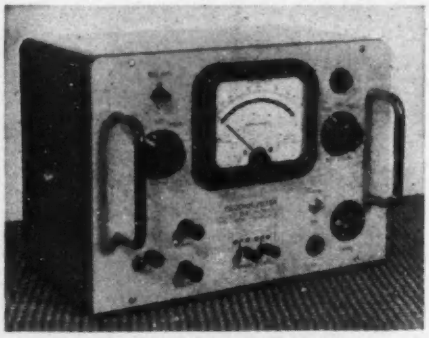

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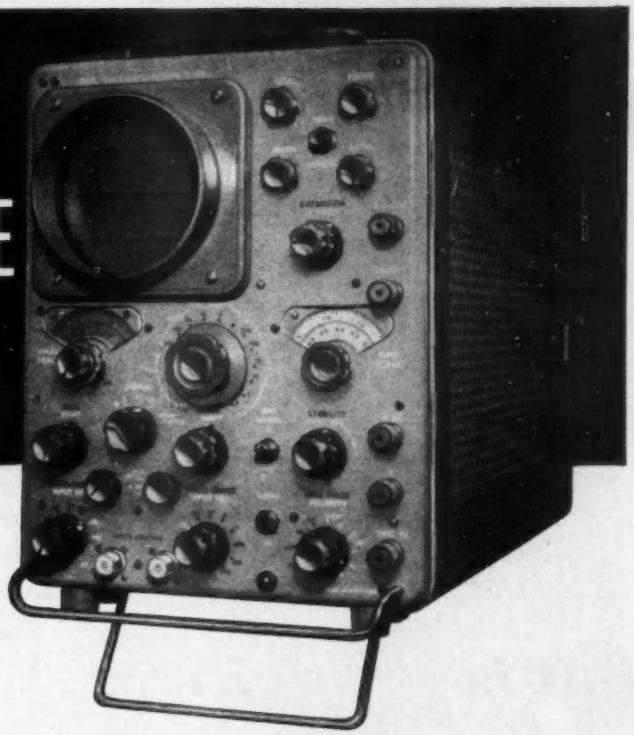
15 Mc/s OSCILLOSCOPE £390



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- Choice of alternating or chopped display
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- 2% measuring accuracy on voltage and time
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- Can also be switched to single-beam operation

The price of the TF1331 is well below that of any dual-trace oscilloscope of comparable specification. A quality general-purpose instrument, it incorporates the high accuracy voltage and time measuring methods standard with Marconi oscilloscopes.

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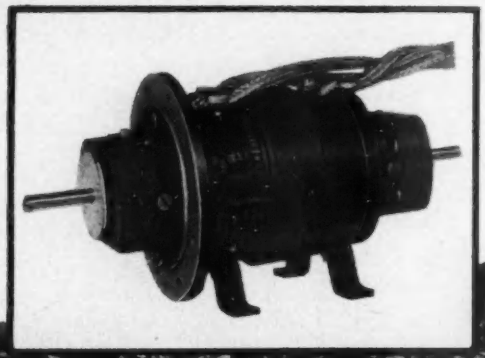

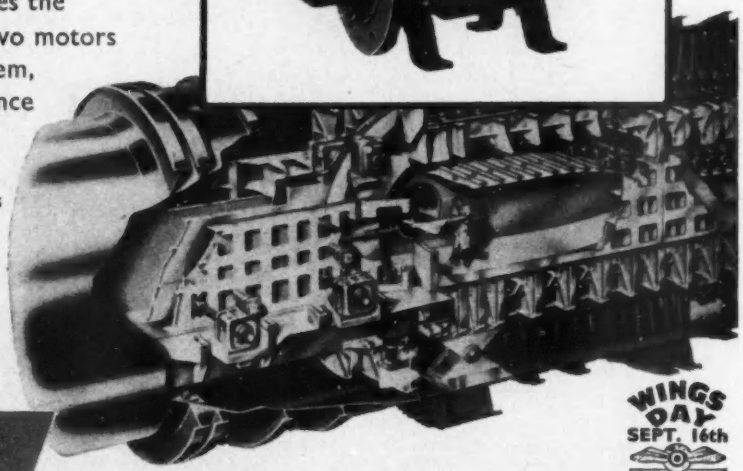

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PHILCO Italiana

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MARCONI TEST EQUIPMENT

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Marconi test equipment, including the Wave Analyser TF 455E (at left), being used to test the distortion of the low-frequency amplifier of a transistored receiver undergoing development.

In Italy, people happily go home to their Philco radio and television receivers. For Philco realise that the continued success of their products is due to a rigorous adherence to quality standards. It follows naturally that this leading Italian company employs a wide variety of Marconi instruments. Prominent in this picture is the Wave Analyser TF 455E, a highly selective and sensitive Analyser for the accurate evaluation of both absolute and relative levels of individual components of a complex waveform. It covers the frequency range 20 c/s to 16 kc/s.

For full details of Wave Analyser TF 455E, an instrument which has many uses in testing audio equipment, write for Leaflet E193. Please mention any other fields of electronic measurement in which you are interested.

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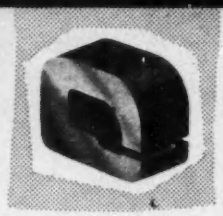
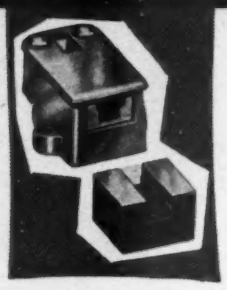
permanent magnets for ELECTRICITY METERS





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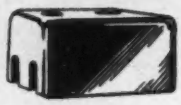

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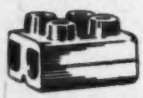

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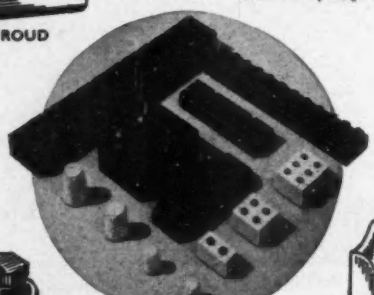

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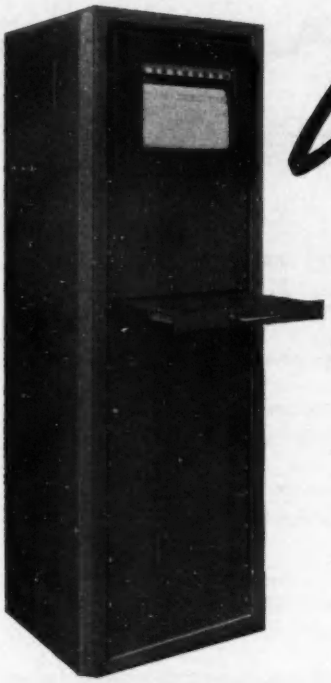

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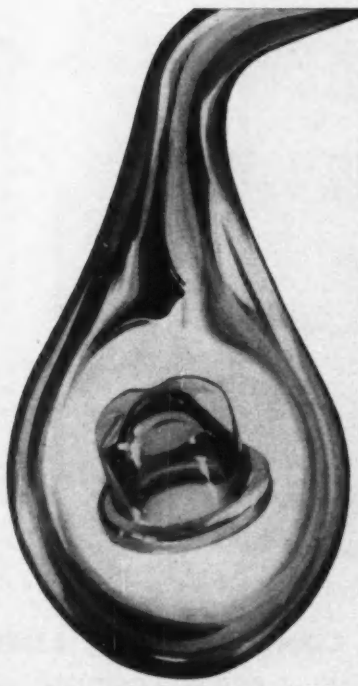

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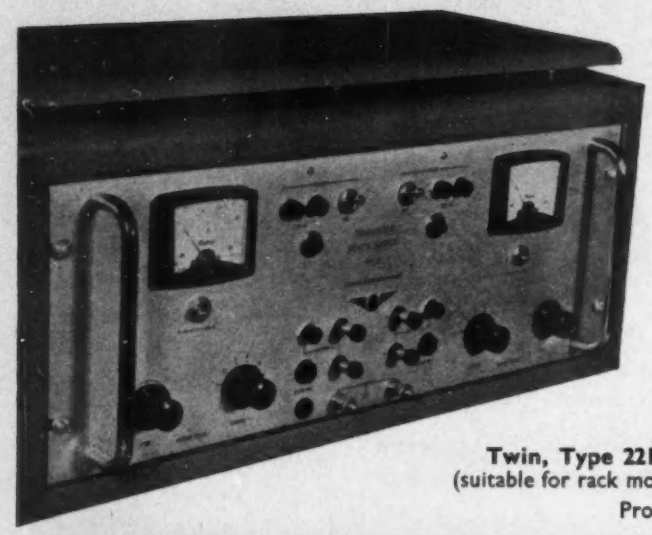

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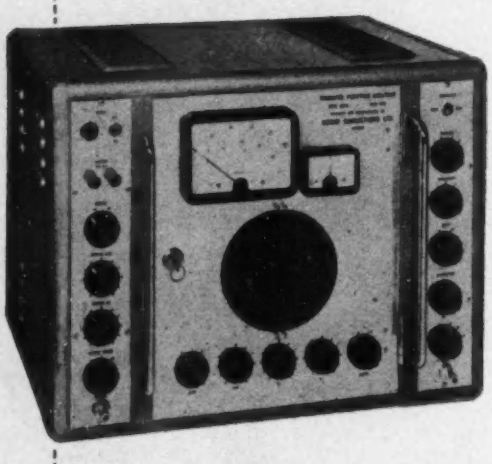

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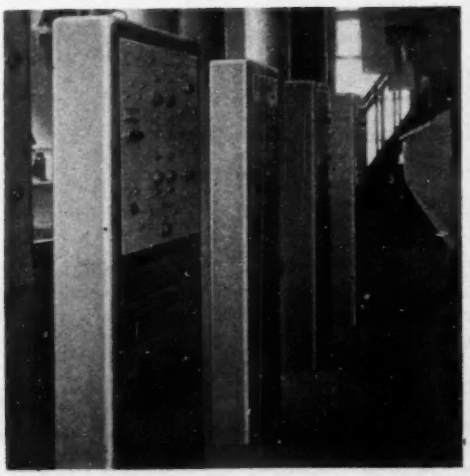
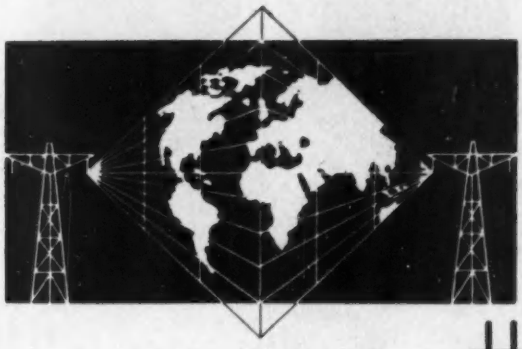
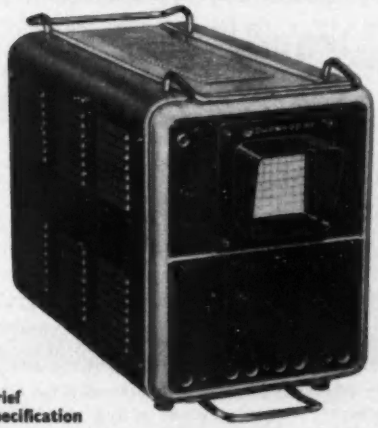


A group of electronic control panels.

GENERAL PURPOSE TWO TRACE OSCILLOSCOPE



Model 2/130 is one of a very wide range of this type of equipment which we are able to supply. Please advise us your requirements, or ask for fully illustrated literature.



Brief Specification

Screen diameter	13 cm, flat
Pattern size of each system	Y direction max. 6 cm X direction max. 10 cm
Y Amplifier Frequency range (3 db)	DC-3 mc/s and DC-10 Mc/s
Rise time	0.12 μsec and 0.035 μsec
X Amplifier Frequency range (3 db)	DC-2 Mc/s
Rise time	0.16 μse. approx.
Time base sweep Frequency range	0.1 c/s—1 M/cs

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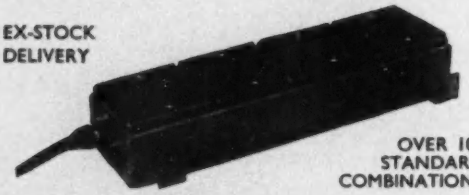

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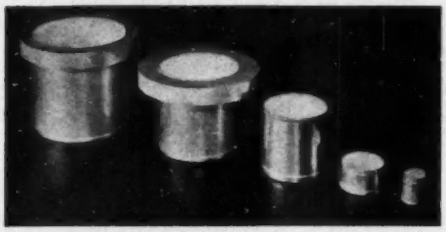

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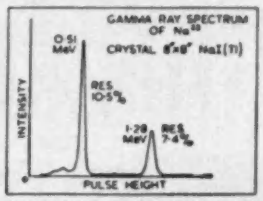

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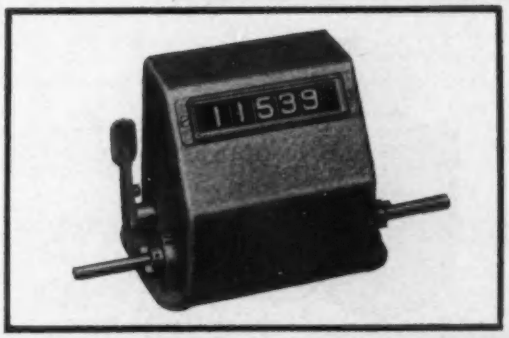

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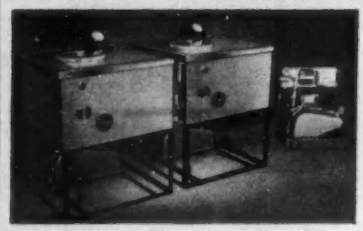

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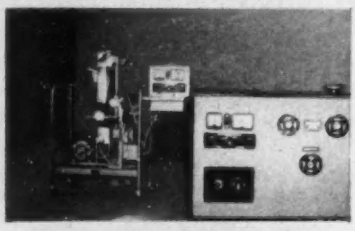

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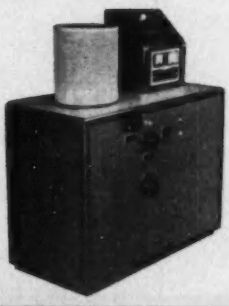

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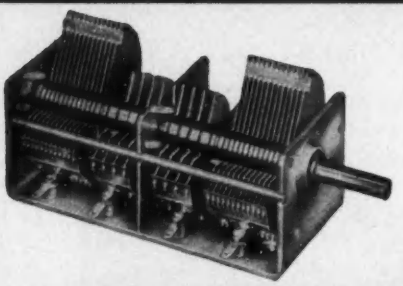

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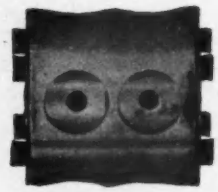
This Metastream ES Coupling

(illustration approx. actual size)



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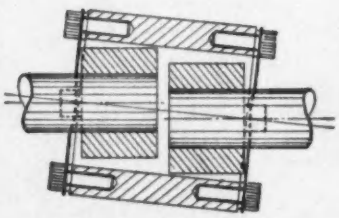

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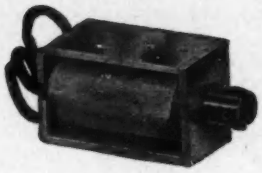

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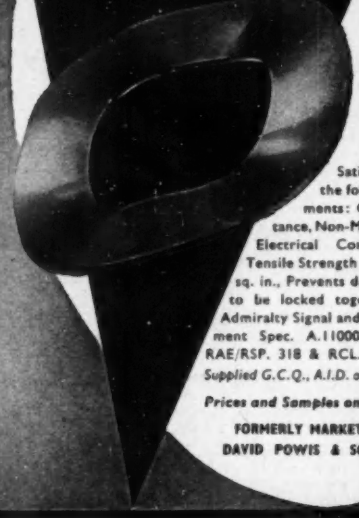

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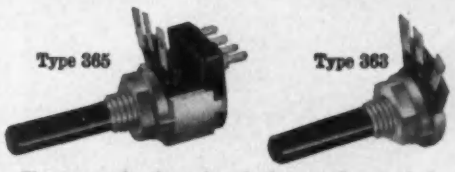

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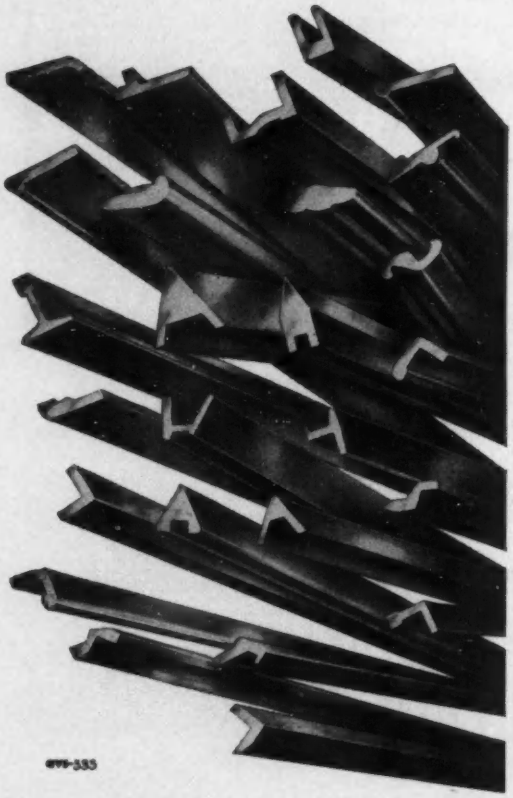

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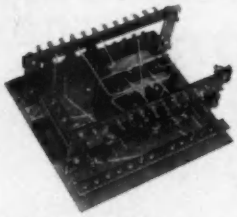

The Basic Logic Units, OR, AND/NOT, LATCH etc operate for standard signals of 1·5V into 68 ohms, and provide an output of approximately 4·5V into 47 ohms; sufficient to drive any Sanders transductor, 2 Watts to 10K Watts output. The Latching Units have "MEMORY" i.e. they will remain latched during total power failure.

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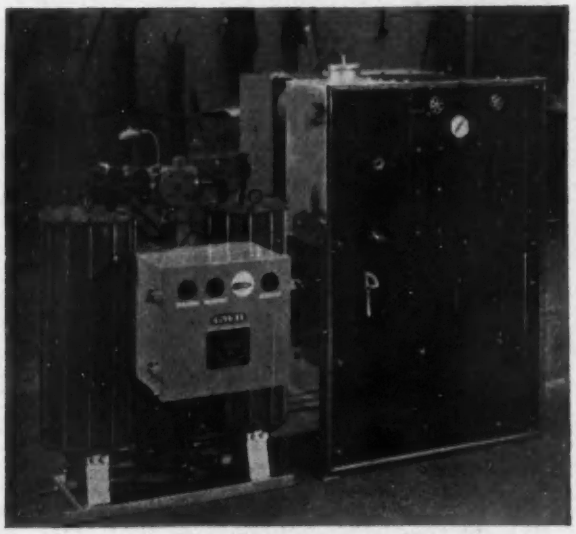

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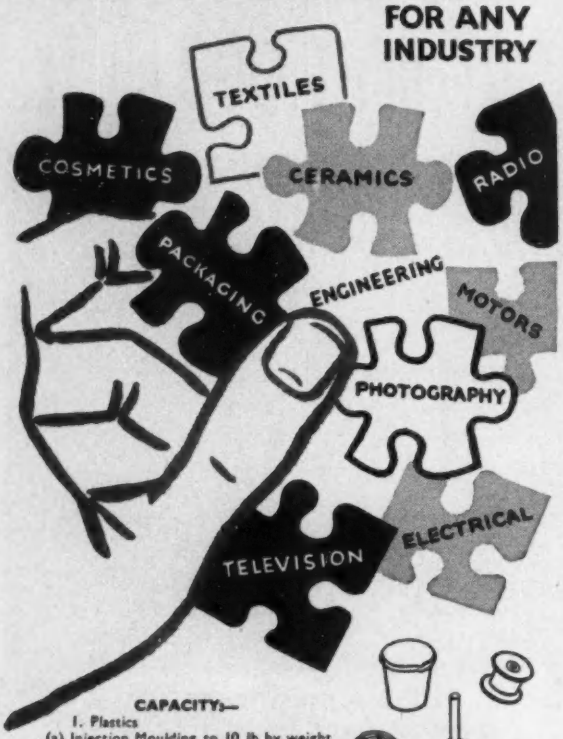

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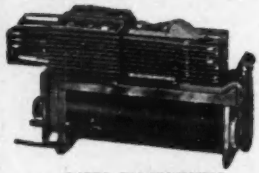

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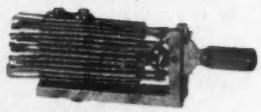

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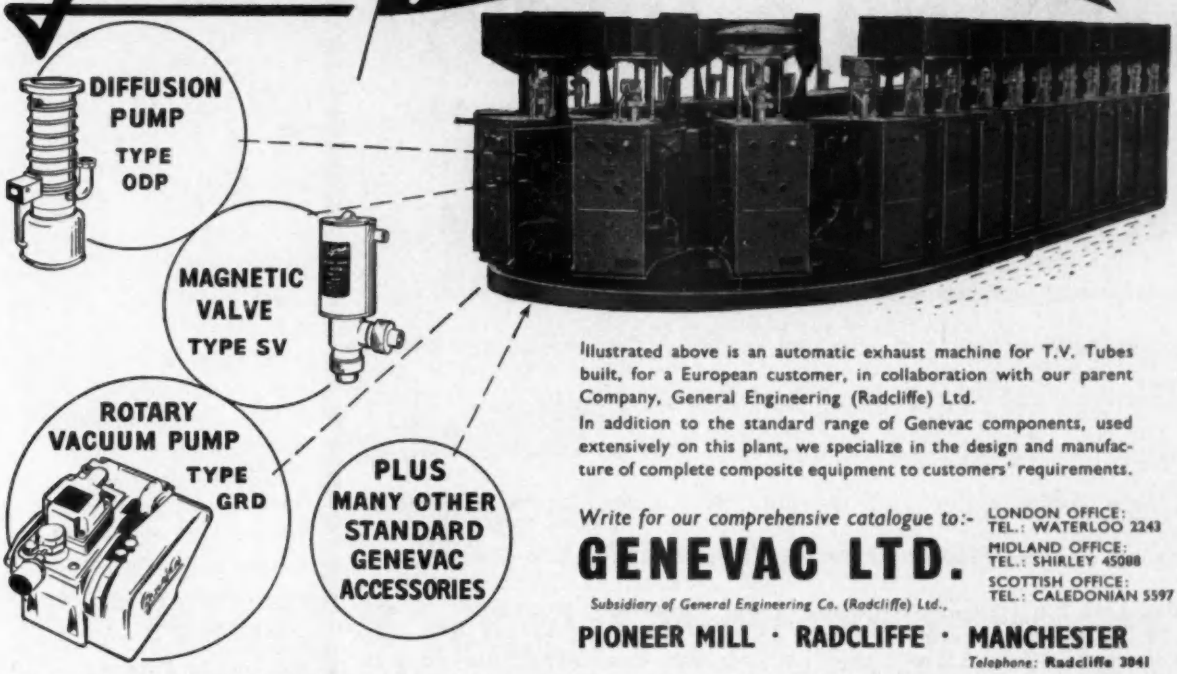

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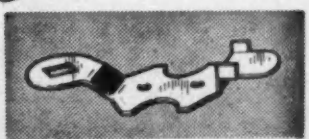

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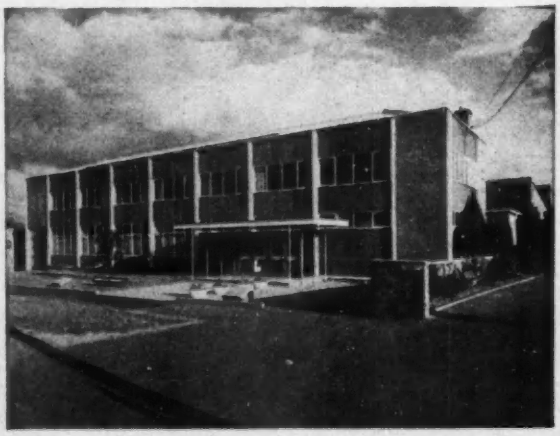

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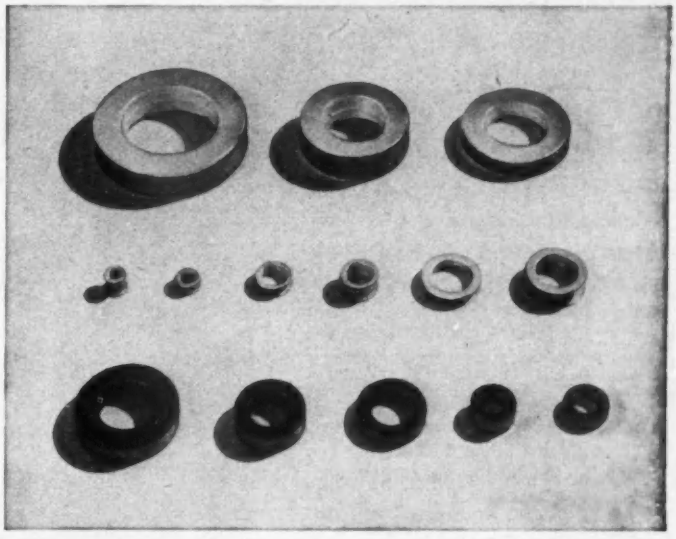

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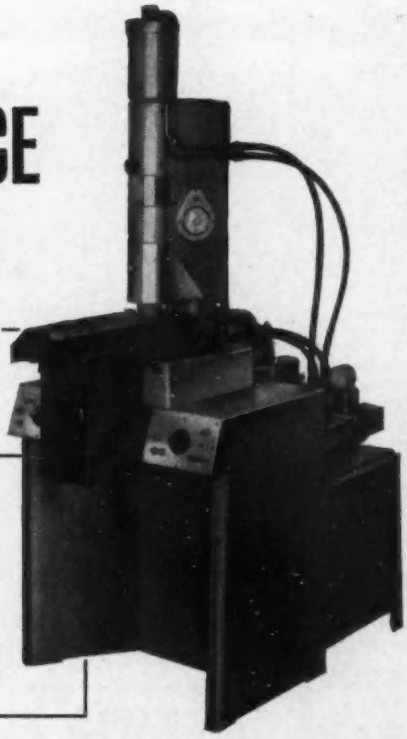

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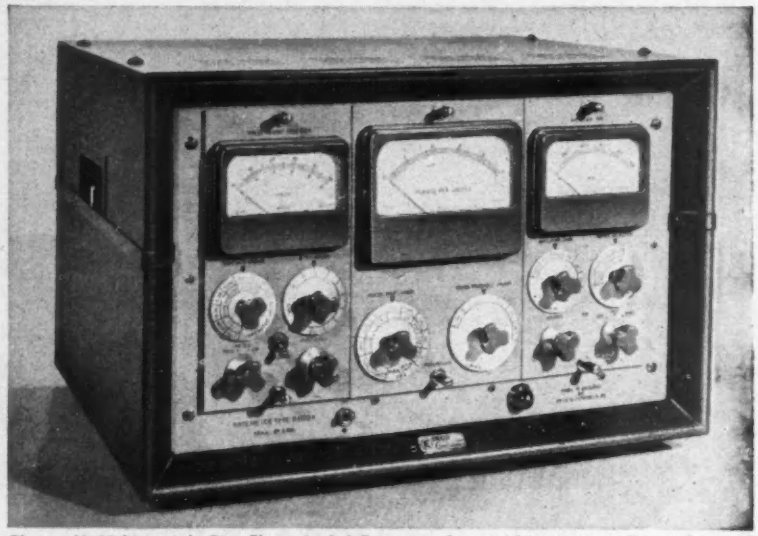

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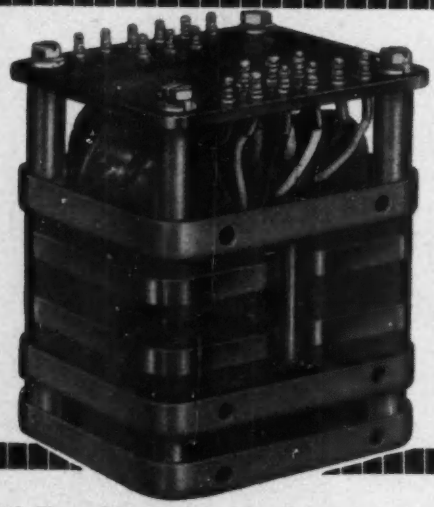

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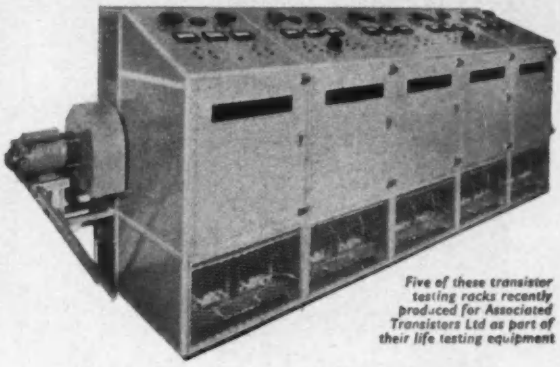

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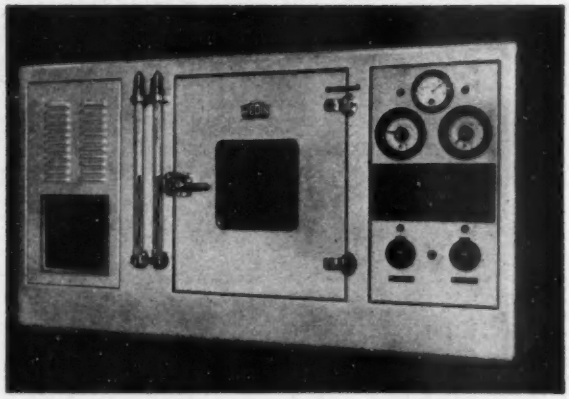

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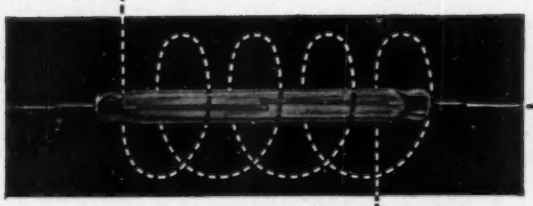

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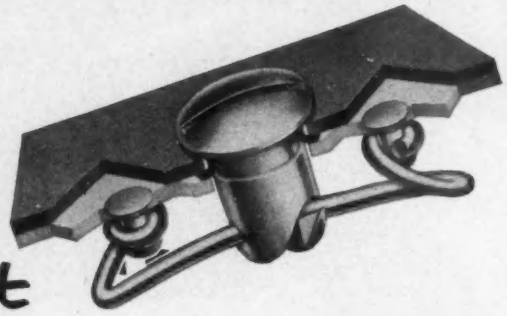

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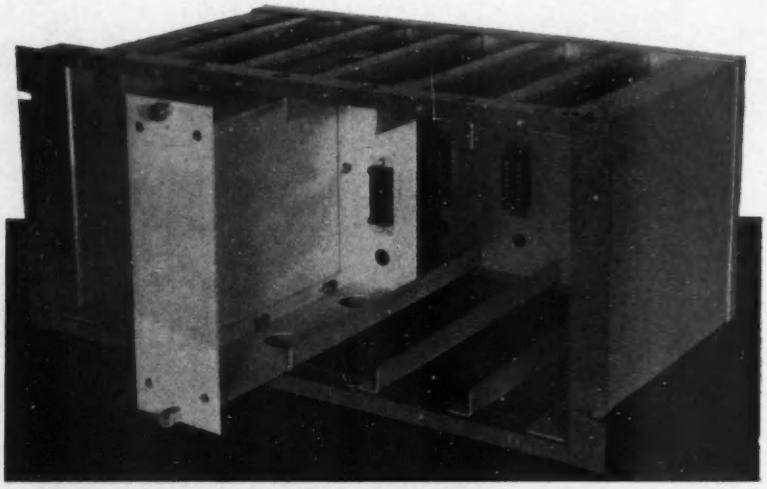

Chassis-nests measure 8¾" x 19" x 10½" (front to back)
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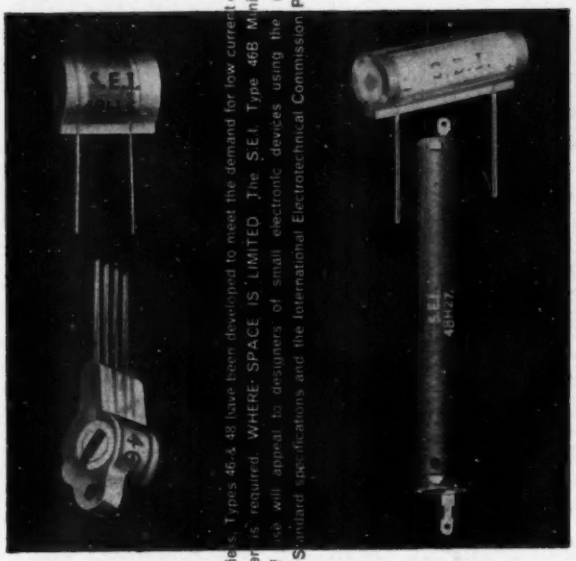

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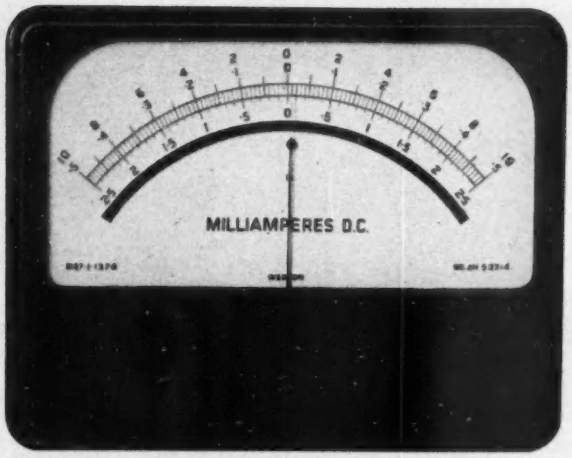

special multi-range meter produced for Ultra in 14 days

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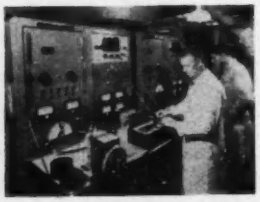

This multi-range meter, using Sangamo Weston S.157, is one of several similar instruments produced by Anders for Ultra Electronics Limited within 14 days. The meters are used in Ground Test Equipment supplied to B.O.A.C. (shown left) for testing the Ultra Engine Throttle Control fitted in Bristol Britannia Aircraft. A typical example of the quick service Anders are giving to many famous firms. Anders are indebted to Ultra Electronics Limited and B.O.A.C. for permission to illustrate this equipment.

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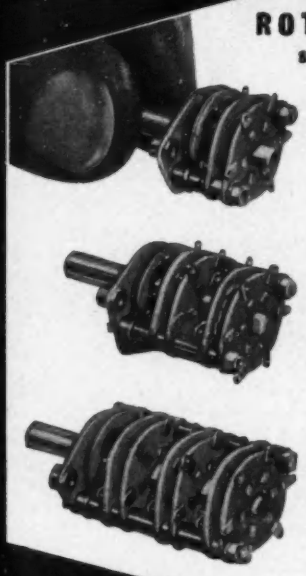

TYPICAL SPECIFICATION

Initial contact resistance	5 mΩ maximum.
After 10,000 operations	10 mΩ maximum.
Insulation resistance:	
Between contacts	Greater than 5,000 MΩ at 500v DC.
Between contacts and spindle	
Contact rating	50 mA at 300v DC or AC. 500 mA at 30v DC or AC.
Capacity between contacts or contacts and spindle	0.5 pF approx.
Indexing interval	60°.
Turning torque	5 to 20 oz.ins., 360 to 1440 g.cms.
Maximum end stop torque	8 lb.ins., 9200 g.cms.
Weight:	
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Each additional bank	0.08 oz., 2.27 g.

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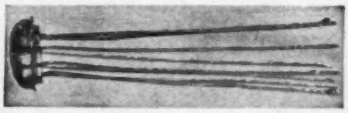

50/1000" OUTSIDE DIAMETER

Actual-size photograph showing one of our small ferrite ring cores mounted on glass base and encapsulated in resin. This particular core carries four windings of 20, 10, 10 and 5 turns of 48 s.w.g. enamelled wire.

Coils such as these are manufactured entirely in our Newport Pagnell factory.

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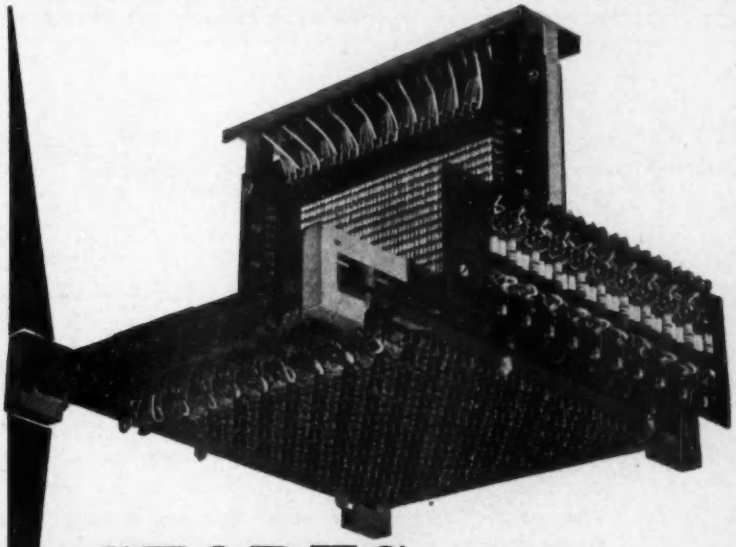

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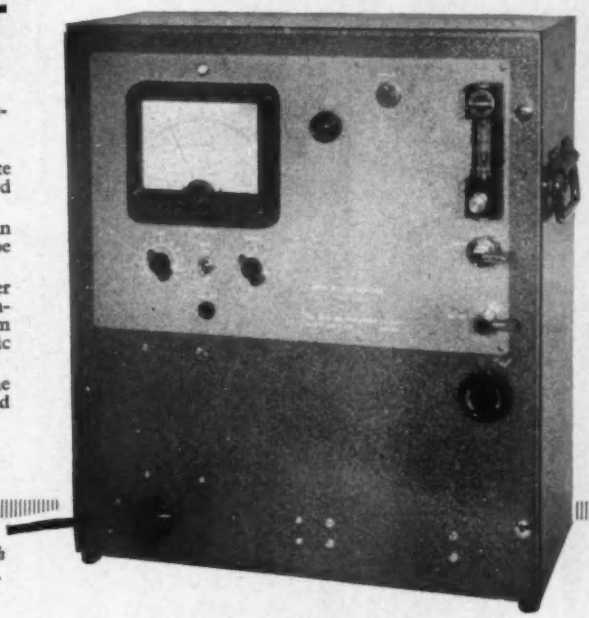

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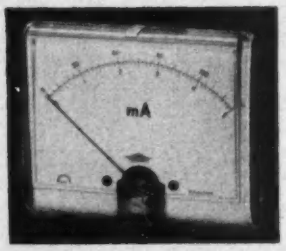

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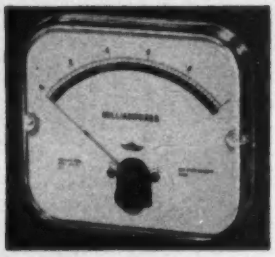

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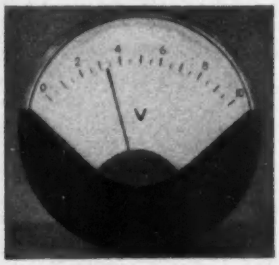

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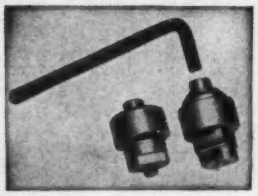

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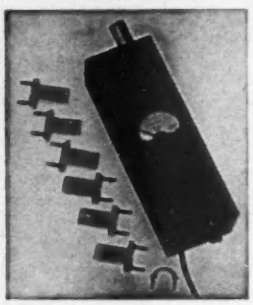

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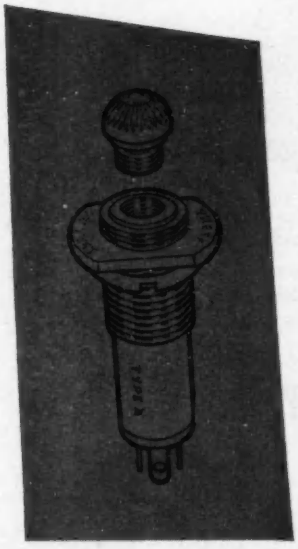

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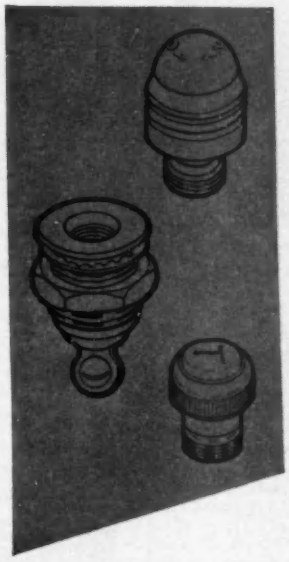

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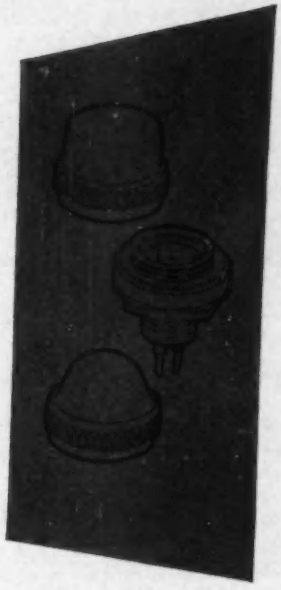

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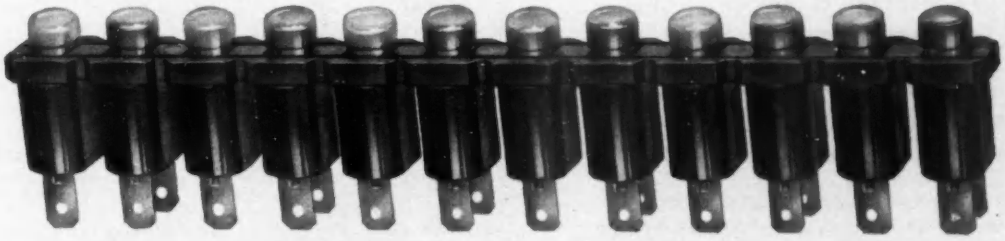

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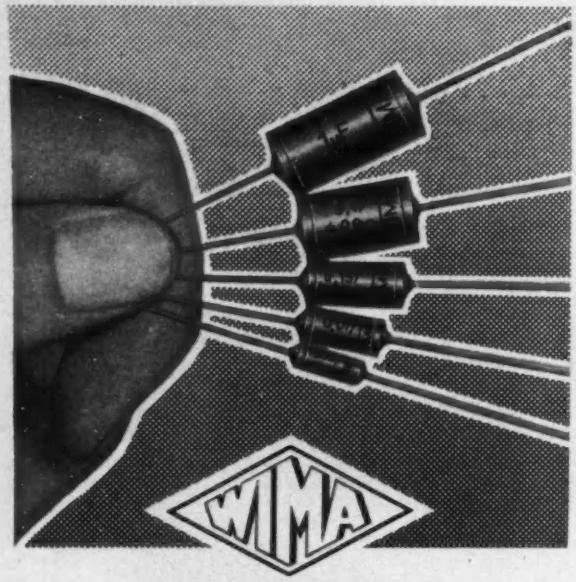

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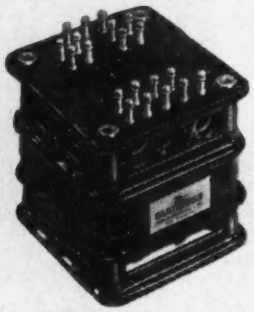

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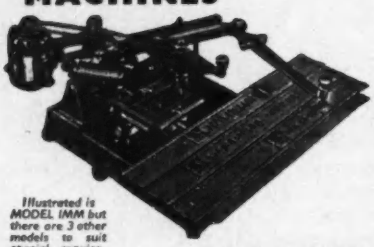

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Display Classified—Full Page, £75 (based on specially spaced classified rates). Half Pages, Quarter Pages and Eighth Pages *pro rata*. Copy dates: With proofs, 5th of preceding month. Without proofs, 10th of preceding month.

Blocks must be mounted.

Advertisements for publication should be addressed to:

Classified Advertisement Dept., "Electronic Engineering", 28, Essex Street, Strand, London, W.C.2.

OFFICIAL APPOINTMENTS

APPLICATIONS ARE INVITED for posts as Engineer Technicians in radio stations in the United Kingdom and overseas. Vacancies are in the following grades: Engineer Technician I, Salary Scale (national rate), £1,128-£1,388. Engineer Technician II, Salary Scale (national rate), £988-£1,288. Engineer Technician III, Salary Scale (national rate), £827 (at age 26)-£988. Engineer Technician IV, Salary Scale (national rate), £666 (at age 25)-£884. During service overseas additional allowances are paid and free furnished accommodation is provided for officers and their families. Candidates must hold City and Guilds certificates in Telecommunications or the O.N.C. (Electrical engineering), and must have had training and experience in electronic work, including, preferably, experience in high power transmission, broadcast practice or in the operation and maintenance of communications transmitters and receivers and ancillary equipment, knowledge of telegraph printing machinery would be an advantage. Selection will be by interview. The grade of appointment offered will depend upon qualifications and experience. All first appointments will be unestablished but there may be opportunities of establishment at a later date. Candidates and both their parents must have been British subjects or citizens of the Irish Republic at all times since birth. Candidates must be prepared to undergo a medical examination. Applications in writing, giving age, qualifications and experience should be addressed to the Personnel Officer, Diplomatic Wireless Service, Hanslope Park, Wolverton, Bucks. W 5274

BRADFORD INSTITUTE OF TECHNOLOGY Department of Electrical Engineering. Applications are invited for a Research Assistantship in the Department of Electrical Engineering. Candidates should have a good honours degree or Diploma in Technology in Electrical Engineering. An interest in research in the field of voltage stabilisers or tape recorders would be an advantage but not essential. Salary in accordance with the Burnham Technical Award for Assistants Grade A (£520-£1,000 per annum, plus training and graduate allowances). Further particulars and forms of application may be obtained from the Registrar, (Department L), Bradford Institute of Technology, Bradford 7. Henry Patten, Clerk to the Governors. W5276

CAREERS FOR RADIO TECHNICIANS in Civil Aviation. Vacancies for Radio Technicians aged 19 or over at airports and radio stations throughout the United Kingdom, maintaining radio communication and electronic navigational aids. Fundamental knowledge of radio with some practical exp. required for entry. Training given on the equipment in use. *Salary* approx. £810 at age 25, rising to £930. 3½ weeks holiday with pay. Paid sick leave. Facilities to study for higher quals, giving good prospects of pensionable posts and promotion to Telecommunications Technical Officer grades with salary max. £988, £1,128 and £1,388. Apply for further details to Ministry of Aviation (Est./5a), Room 755, Adelphi, John Adam St., London, W.C.2, or any Employment Exchange, quoting Westminster O/N. 3552. W 5219

CHARING CROSS HOSPITAL GROUP, Fulham Hospital. Physics technician required for new radio-isotope laboratory. Applicants should have Ordinary National Certificate, Inter B.Sc., City & Guilds Intermediate or equivalent qualifications or experience (medical laboratory, electronics or radiography). Whitley Council scale, £710-£905 +London Weighting. Write, with two names for reference, House Governor (A), Charing Cross Hospital, W.C.2, by 10th August. W 5265

CITY OF PORTSMOUTH College of Technology, Department of Mathematics and Physics. Applications are invited for the post of Research Assistant. The person appointed will be expected to take part in research work on the microwave properties of certain magnetic oxides and to undertake a certain amount of teaching. The appointment is for 3 years and is intended to enable a candidate to prepare for a higher degree. Salary is in the range £650 to £700. Further particulars and a form of application, which should be returned by 11th August, may be obtained from the Registrar, College of Technology, Park Road, Portsmouth. W 5269

INSTRUMENTATION AND CONTROL ENGINEER. National Research Council, National Aeronautical Establishment, Ottawa, Ontario, Canada. The National Aeronautical Establishment requires an experienced engineer capable of initiating the design of new instrumentation and transducers, data handling equipment and control systems for the Aerodynamics Section. The laboratories of this Section are equipped with a wide range of subsonic, supersonic and hypersonic wind tunnels and short flow duration research facilities. The successful applicant will have the support of an experienced instrumentation group, mechanical design office and newly equipped workshops as well as the use of analogue and digital computers. The opportunity exists to follow a design through all stages up to the final installation and operation. Candidates must be graduates with honours from a recognised University in Electrical Engineering or Physics (or equivalent) and must have several years of pertinent experience. For example, they must be familiar with the application of electrical transducers, automatic electric and hydraulic controls, and data processing systems and must be capable of an original approach to the many instrumentation and control problems posed by aerodynamics research. Salary up to $10,000 per annum is offered for this position, depending on the qualifications and experience of the applicant. Apply giving age and complete details of education and experience to the Employment Officer, National Research Council, Sussex Drive, Ottawa 2. Please quote file NAE-61. W 5278

HERTFORDSHIRE COUNTY COUNCIL. College of Technology, Letchworth. The Governors invite applications for a position as Lecturer in Electrical Engineering. Interest in Electronics and/or Automatic Control an advantage. Salary scale (under revision) at present £1,370 to £1,550. Applications in full detail should be sent immediately to: The Principal, College of Technology, Broadway, Letchworth. W 5225

LABORATORY SENIOR TECHNICIAN (Physics) Queen Mary College, (University of London), Mile End Road, E.1. Salary placing on scale £690 × £25—£815 p.a. according to ability. London Weighting up to £45 and possible qualifications supplement of £30 or £50. Pension Scheme. Five day week. Four weeks annual leave. The person appointed will if found suitable be in charge of the electronics workshop. Letters only to Registrar (PST), stating age, full details experience and present work. W 5257

MINISTRY OF AVIATION, Leicester, require Technician to assist in the supervision of inspection at a large factory manufacturing radar and other electronic equipt. Applicants should have sound knowledge of electronics. Exp. in inspection and testing of electronic equip. an advantage. Quals. ONC, C & G. Final Certs. or equiv. Recognised eng. apprenticeship or equiv. training. Salary: £988 (on entry)—£1,128. Good prospects for advancement and pension. Technical College courses sponsored for suitable candidates. Application forms from Manager (P.E.2239), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon St. London, E.C.4. W 5256

MINISTRY OF AVIATION, Boreham Wood, Herts, requires Technician for supervision of contractor's approved inspection organisation covering the manufacture of electronic airborne navigation equipt. and special types of electronic valves. Applicants should have experience and a sound knowledge of electronic engineering. Quals. ONC, C & G. Final Certs. or equiv. Recognised eng. apprenticeship or equiv. training. Salary: £1,028 (on entry)—£1,173. Good prospects for advancement and pension. Technical College courses sponsored for suitable candidates. Application forms from Manager (P.E.2240), Ministry of Labour, Professional & Executive, Atlantic House, Farringdon St., London, E.C.4. W 5255

POST OFFICE (a) Assistant Engineer (about 10 posts for men), (b) Telecommunications Traffic Superintendent (about 75 posts for men and women). All pensionable. Age on 1/9/61: 17½ and under 23½ for (a), 17½ and under 24½ for (b); with extension for Forces service, Overseas Civil Service, and (up to two years) established civil service. Duties: (a) technical design and development of telecommunications equipment, (b) planning and management of telephone services. Qualifications for (a) and (b): G.C.E. (or equivalent) in English Language and 4 other subjects, including 2 at A level obtained at same examination from Pure Mathematics, Applied Mathematics, Pure and Applied Mathematics, Physics, Chemistry. Selection by interview. Salary (inner London): (a) £620 at 18, 19, 20, £679 at 21, £847 at 25 or over, rising to £1,282; (b) £659 at 18, £695 at 21, £851 at 25 or over, rising to £1,214. Promotion prospects. Write, Civil Service Commission, Burlington Gardens, London, W.1, for application forms, quoting (a) 291/61, (b) 303/61. Closing date 12th September, 1961. W 5268

THE ROYAL COLLEGE OF ADVANCED TECHNOLOGY, Salford, Department of Electrical Engineering. The Department will shortly proceed to fill several vacancies created by the expansion of the College. Applications are invited from Electrical Engineers and from Physicists who have a special interest in electrical engineering. Posts are available at all levels. Scales are at present under review, but it is expected that certain posts will carry salaries in excess of £2,000 p.a. Applicants should have an honours degree and preferably some research or industrial experience; specialists in heavy current engineering are required for certain posts. Previous lecturing experience, although desirable, is not essential to an appointment at any level; honours graduates of 1961 may be considered for one appointment. Persons interested should write, giving full details of their qualifications and experience, to the Head of Department, Dr. J. H. Calderwood, from whom further information about the posts which they are eligible to compete may be obtained. Such enquiries will be treated as confidential, and no approach will be made to the employers of those making enquiries without their express permission. W 5270

OFFICIAL APPOINTMENTS (Cont'd.)

PATENT EXAMINERS AND PATENT OFFICERS. Pensionable posts for men or women for work on the examination of Patent applications. Age at least 20 and under 29 (36 for Examiners) on 31/12/61, with extension for regular Forces service and Overseas Civil Service. Qualifications: Normally a degree, or a Diploma in Technology, with first or second class honours in physics, chemistry, engineering or mathematics, or equivalent attainment, or professional qualification, e.g. A.M.I.C.E., A.M.I. Mech.E., A.M.I.E.E., A.R.I.C., A.Inst.P. Inner London salary £793 to £1,719; provision for starting pay above minimum. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/128/61, and stating date of birth. W 5267

R.N. COLLEGE, GREENWICH, LONDON, S.E.10. Post for Senior Lecturer or Lecturer in Physics and Electrical Engineering available January, 1962. Candidates (male) must be British and possess an appropriate Honours degree. Duties include lecturing and conducting laboratory work to degree standard and post-graduate teaching. Special experience in telecommunications an advantage. Excellent research facilities. Appointment as Senior Lecturer (£1,392–£1,714) or Lecturer (£773–£1,267) according to age, qualifications and experience. Starting salary above minimum may be authorised. Post carries F.S.S.U. benefits. Single accommodation available. Particulars and application forms from Director (P), Education Department, Admiralty, London, S.W.1. Closing date for applications 31st August, 1961. W 5279

UNIVERSITY OF SOUTHAMPTON. Senior Technical Assistant required in Physics Department to help in design and construction of electronic and other instruments to be used in rockets and artificial earth satellites. Desirable qualifications: experience in use of transistors, familiarity with nuclear instrumentation and some knowledge of workshop practice. Appointment for three years in first instance. Salary up to £845 per annum according to experience. Applications, giving full details of experience and qualifications and names of two referees, to Secretary and Registrar, University of Southampton, as soon as possible. W 5266

UNIVERSITY OF SOUTHAMPTON. Department of Electronics. Applications are invited for research assistantships in various branches of electronics including millimetre-wave generation, parametric amplifiers, tunnel-diode amplifiers, microwaves and Barkhausen noise. Applicants should possess an honours degree in electrical engineering or physics, or an equivalent qualification. Salaries up to about £600 per annum are available and the persons appointed will be encouraged to register for a higher degree. A senior research assistantship for the study of noise in travelling-wave tubes is also available (salary up to £1,000 per annum including F.S.S.U.). Applications, including full details of qualifications and the names of two referees, should be sent to the Secretary & Registrar, the University of Southampton, before 5th August, 1961. W 5263

VICTORIA UNIVERSITY OF WELLINGTON, New Zealand. Senior Lecturer in Applied Electronics. Applications are invited for the above-mentioned appointment. The primary purpose of the appointment is to advance the practice of Applied Electronics generally and the appointee will be expected to do this by all appropriate means. He will be expected to initiate research or development work having a bearing on New Zealand industry, to seek a close acquaintance with industrial problems and opportunities in New Zealand, and to foster a knowledge of basic electronics within industry. An annual grant will be made by the University to assist this work. The appointee will be attached to the Department of Physics and his teaching and other duties will be suitably restricted in scope so as not to interfere with the primary purpose of the appointment. The salary will be £1,750 per annum rising to £2,000 per annum. The initial salary will be determined according to the qualifications and experience of the appointee. Approved fares to Wellington will be allowed for the appointee, his wife and his dependent children. In addition, actual removal expenses will be allowed within specified limits. Further particulars, and information as to the method of application, may be obtained from the Secretary, Association of Universities of the British Commonwealth, Marlborough House, Pall Mall, London, S.W.1. Applications close in New Zealand and London on 1st September, 1961. W 5272

UNIVERSITY OF SYDNEY. Lectureship/Senior Lectureship in Electrical Engineering. Applications are invited for the above-mentioned position. Candidates should be well qualified in Electrical Engineering or Physics and should have had general experience in electronics and have considerable detailed knowledge of solid state devices and circuits. It is anticipated the successful applicant will take part in the teaching of electronics and communication engineering, including fundamental aspects of solid state devices and circuits, and in research on solid state devices and their application in communication engineering systems. The salary for a Senior Lecture is within the range £A2,550×95—£A3,000 per annum; for a Lecturer within the range £A1,730×105—£A2,435 per annum. In each case cost of living adjustments will be allowed (at present £A42 p.a.). The salary is subject to deductions under the State Superannuation Act. The commencing salary will be fixed according to the qualifications and experience of the successful applicant. Under the Staff Members' Housing Scheme, in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house. Further particulars, and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, Marlborough House, Pall Mall, London, S.W.1. Applications close in Australia and London on 15th September, 1961. W 5271

SITUATIONS VACANT

A PRODUCTION CHIEF ENGINEER, who will be responsible to the Managing Director, is required for the Electronics Subsidiary of a large well-known Public Company, to take over existing production and set up production lines for Closed-circuit Television Equipment. This position is permanent and progressive within the Group, and applicants must have extensive practical experience and detailed knowledge of planning methods. The starting salary envisaged is in the region of £1,500 per annum, and the Company operates a contributory pension scheme with free life assurance. Apply: The Company Secretary, Nottingham Electronic Valve Co. Ltd., Main Street, East Bridgford, Notts. W 5262

ARE YOU INTERESTED in joining a team of Design and Development Engineers engaged in producing auto-pilots for new helicopters now under development? Louis Newmark Ltd. of Croydon are desirous of appointing Design Engineers and Assistant Engineers to these posts, senior and junior appointments are available. Please send details of qualifications and experience to Personnel Manager, Louis Newmark Ltd., Gloucester Road, Croydon. W 351

ELECTRICAL/ELECTRONIC ENGINEER. A major manufacturer of laboratory instruments and apparatus has a vacancy for a Section Leader in its Research and Development Division based on N.E. London. Inventiveness, backed by at least H.N.C. and varied small-scale industrial experience is desirable. Pension Scheme. 5-day week. Holiday arrangements honoured. Box W 5238.

ELECTRONIC DESIGN / DEVELOPMENT ENGINEERS required for expanding R. and D. Division of Electronics Group. Previous proved ability in the design of units for medium and small quantity production runs is desirable. Candidates must have transistor or U.H.F. experience and should be of Degree Standard or equiv. Mechanical Design experience would be an advantage. Proven ability to design will be accepted as a suitable qualification. Salary will be commensurate with the applicants qualifications and experience. Please apply in writing to the Chief Engineer, Beme Telecommunications Ltd., Hythe, Hants. W 5234

ELECTRONIC ENGINEER required for development of transistor circuits. Age 20 to 28. Progressive and permanent position. Commencing salary £1,500 to £1,800 p.a. Contributory Pension Scheme. Box No. W 5215.

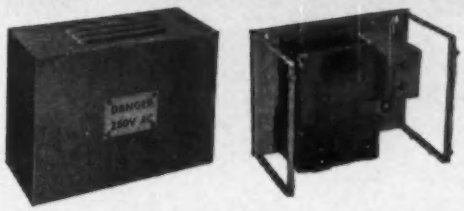
THE INDEPENDENT TELEVISION AUTHORITY invite applications for the appointment of (a) Engineer to work on radio wave propagation problems in connection with television broadcasting. The work will cover the prediction of service areas of transmitting stations and relay link planning. Applicants should possess a degree or equivalent qualification and preferably have some experience of radio wave propagation work. Commencing salary in the scale £1,015-£1,650 per annum depending upon experience and qualifications. (Reference Number EE/A/143/23). (b) Engineer to work on a variety of problems in connection with television reception and field strength measurement. The work will include some development of prototype equipment and calibration of measuring gear. Candidates must possess a recognised engineering qualification or have pursued a regular course of study in electrical engineering. Commencing salary in the scale £1,015 to £1,425 depending upon experience and qualifications. (Reference Number EE/A/144/24). The appointments will be based in London but will involve some travelling and absence from home. Normally this absence will be for short periods only and a subsistence allowance is payable during absence from base. There is a contributory Pension Scheme and other benefits are available after a suitable period of service. Applications to the Personnel Officer, I.T.A., 62, Brompton Road, London, S.W.3, not later than 14th August, 1961, quoting the appropriate reference number. W 5280

CLASSIFIED ADVERTISEMENTS
continued on page 190

ELECTRONIC EQUIPMENT

The items shown here are representative of the extensive variety of products manufactured by the Whiteley organisation. Our technical resources are available for the development and production of specialised components for the electronic industry.

See us at the SBAC Show



CONVERTER RINGING

Manufactured for the G.P.O., the converter is a static frequency changing device supplying approximately 60 volts at 25 cycles from a 50 cycle mains supply. Its function is for ringing magneto bells.

P.O. TESTER AT.5422

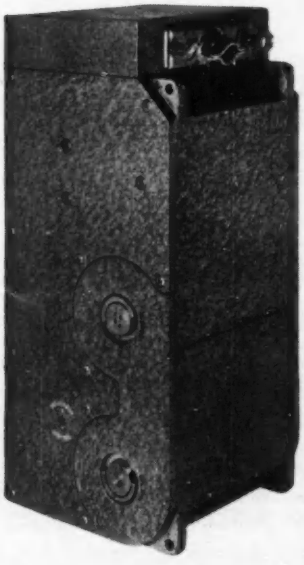
This tester is manufactured for the G.P.O. and is used by them for checking and testing Post Office telephone lines.

P.O. TESTER SA.9116

This tester is primarily designed for the measurement of cable sheath potentials. It operates as a potentiometer type voltmeter for measuring potentials up to 1.0 volts and as a direct reading voltmeter for potentials up to 10 volts.

WB 161

WHITELEY ELECTRICAL RADIO CO. LTD · MANSFIELD · NOTTS



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EE 36 238 *for further details*

SITUATIONS VACANT (Cont'd)

HIVAC COMPANY a Company associated with a major group in the telecommunications field, requires Engineers and Physicists for work in the development, production control and application of valves, cold cathode tubes and similar devices. Previous experience in these fields would be an advantage but is not essential. Vacancies exist for both senior and junior staff. The posts are pensionable and offer considerable scope for advancement. Applications, which will be treated in strict confidence, should be addressed to: The Engineer-in-Chief, Hivac Limited, Stonefield Way, Victoria Road, South Ruislip, Middlesex. W 5264

JUNIOR ELECTRONIC DEVELOPMENT ENGINEER. Familiar—general industrial electronics circuitry—with some knowledge of chassis and case design, etc. £650/£800 p.a., Staff position, pension scheme, sick club. Write Grundy & Partners, Ltd., 3, The Causeway, Teddington, Middx. W 5135

OVERSEAS. Electronic Technicians are required by an Oil Exploration Company with Headquarters in the U.K. Men should be single on joining. Work will include the maintaining and operating of field equipment often under conditions of desert, jungle, and swamp. The equivalent of an H.N.C., with practical experience in electronics, is essential. Tours overseas are of up to two years followed by home leave. Write with full particulars, covering any time spent in the Forces, to Box No. W 356.

RADIO ENGINEERS. Senior Electronics Engineers required by internationally known organisation. Candidates must be single, medically fit, prepared to spend periods of up to two years abroad, and be able to accept responsibility for the success of projects. Qualifications: B.Sc., H.N.C. or equivalent plus industrial experience. A knowledge of modern survey technique is an advantage. Please apply to Box No. W 5273.

TECHNICAL SALES REPRESENTATIVE. Leading firm of electrical component manufacturers situated in N.W. London require Technical Sales Representative with first class knowledge of radio, television and electronic industries to cover mainly Southern England territory. Superannuation scheme available for men up to 50 years of age and a car will be provided. Write stating age, experience in chronological order and salary required to Box No. TS 5325. A.K. Advg., 212a, Shaftesbuty Avenue, London, W.C.2. W 5259

UNICAM INSTRUMENTS LTD. The Drawing Office of Unicam Instruments Ltd. has a vacancy for a Designer Draughtsman to work on electronic units used in precision analytical and process instruments. Applicants should have had considerable experience in component layouts. Salary will be in accordance with qualifications and experience. Applications in writing, giving full details, should be addressed to: The Chief Designer, Unicam Instruments Ltd., Arbury Works, Cambridge, quoting reference GF.6 W 5261

SEMICONDUCTOR CIRCUIT ENGINEER required for rapidly expanding company for transistorised power supplies and allied equipment. Write Brandenburg Limited, 139 Sanderstead Road, South Croydon, Surrey. W 359

SERVICE

ELECTRONIC DESIGN, development, prototype manufacture. Sub-contract work undertaken. London area. Box W 2041.

EXTRA PRODUCTION FACILITIES: Skilled workers + floor space + expert supervision = extra production facilities for you. See page 170. W 355

GERALD FISHER ENGINEERING LTD., Lancs. All types of electronic and electrical assembly work undertaken to your requirements. Chassis wiring, cableforms, groupboards. Hampden Road, Shaw, Lancs. Shaw 7509. W 2049

METALWORK. All types cabinets, chassis, racks, etc., to your own specifications. Philpott's Metalworks Ltd., Chapman Street, Loughborough. W 341

TRANSFORMERS DESIGNED AND MANUFACTURED Prototypes or batch productions of all types up to 3 KVA. Prompt delivery. Suppliers to BBC, ITA, Universities and leading Industrial Concerns. Est. 1922. Phone: SHI : 2483. Forrest Transformers Ltd., Shirley, Solihull, Warwickshire. Telephone SHirley 2483. W 350

EDUCATIONAL

CITY AND GUILDS (Electrical, etc.) on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of modern courses in all branches of Electrical Engineering, Applied Electronics, Automation, etc., send for our 148-page handbook —FREE and post free. B.I.E.T. (Dept. 337c), 29 Wright's Lane, London, W.8. W 316

COUNTY BOROUGH OF BOLTON, Education Department, Bolton Technical College. Principal: A. J. Jenkinson, M.A. Electrical Engineering Department, Head of Department, A. C. Normington, B.Sc.(Eng.), M.I.E.E., M.Brit.I.R.E. Diploma in Electronic Engineering. A three year full-time course for the College Diploma. Entry requirements: Four G.C.E. passes, including English language, Mathematics and Physics at "O" or "A" levels. Diplomates are exempted from: The entire Examination of the British Institution of Radio Engineers. Parts I and II of the Examination of the Institution of Electrical Engineers. Further particulars from the Principal, Bolton Technical College, Manchester Road, Bolton. W 5216

BRADFORD INSTITUTE OF TECHNOLOGY. Department of Electrical Engineering. A full-time post-graduate course, of twelve weeks' duration, on Transistors and Transistor Circuit Design will be held commencing 18th September, 1961. Further information may be obtained from the Head of the Department of Electrical Engineering, Bradford Institute of Technology, Bradford, 7. W 5277

LEARN RADIO AND ELECTRONICS the New Practical Way! Very latest system of experimenting with and building radio apparatus—'as you learn'. Free Brochure from Dept. EE10, Radiostructor, Reading, Berks. W 353

TV. AND RADIO—A.M.Brit.I.R.E., City & Guilds, R.T.E.B. Certificate, etc., on "NO PASS—NO FEE" terms. Over 95 per cent successes. For details of Examination and Home Training Courses (including practical apparatus) in all branches of Radio, T.V. and Electronics, write for 148-page handbook—Free. B.I.E.T. (Dept. 337H), 29 Wright's Lane, London, W.8. W 187

FOR SALE

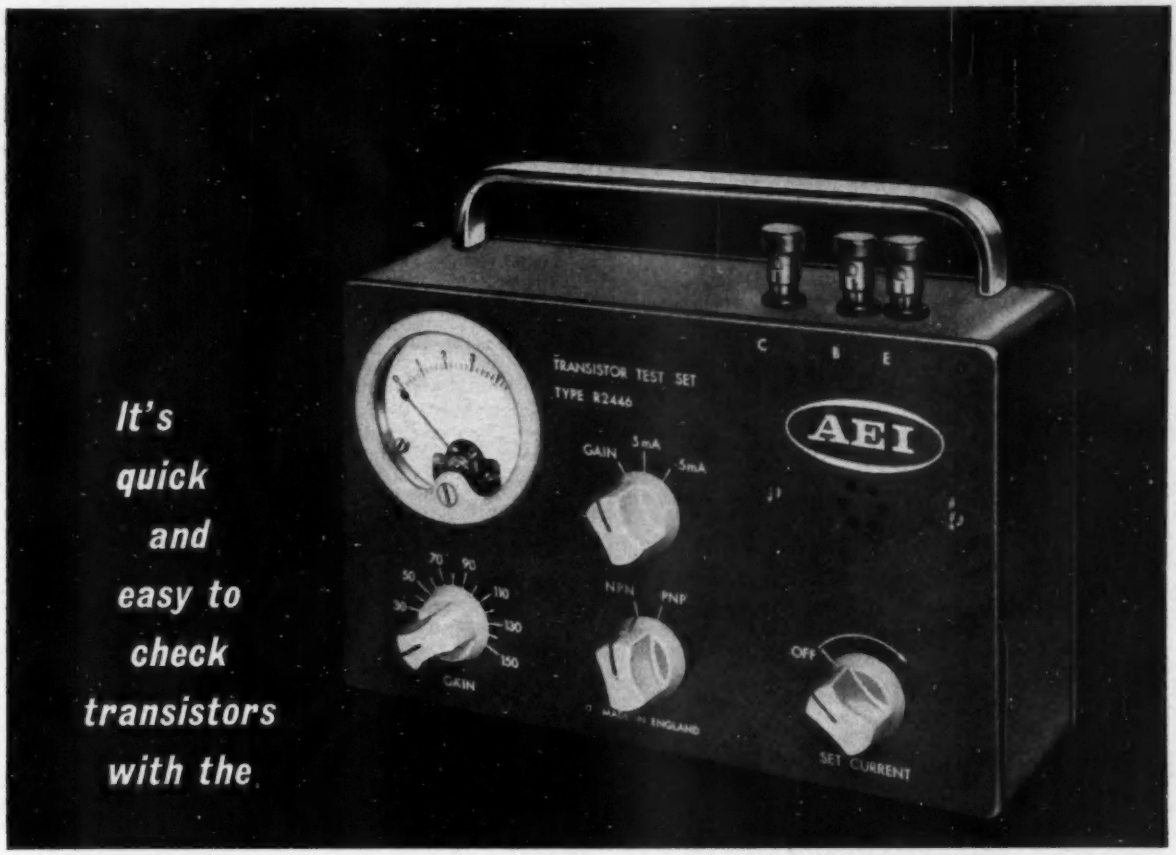
FOR DISPOSAL:— 1 R.F. Power Transmitter type FT 300 by Federal Telephone and Radio Corporation, consisting of Power supply with RRJ/1250 rectifiers and 4 RF. units less oscillators Band 5-13 Mc/s. Modified for Mullard TY4/500 output valves. Working condition, spare valves. 1 Breco Automatic Voltage Regulator type REOR ±4/02, 35 KVA. 1 Ph., 50 c/s 230v. ±10% input, 230v. ±1% output 152 amp. 1 General Radio Valve Voltmeter, old pattern. 1 RF dielectric Heater type RH3 by Redifon 6′×3′×3′ requires attention. 1 Little John bench lathe on mounting with motor, requires attention. 8 Various X-Ray type Rectifier Valves. 11 Type 83 Brimar Valves. Offers to be marked for the attention of the Senior Cyclotron Engineer, Medical Research Council, Hammersmith Hospital, Du Cane Road, London, W.12. Shepherds Bush 4594. W 5258

50,000 PRECISION INSTRUMENT GEARS of all types from stock. (Now including spiral bevels.) Write for fully comprehensive catalogue. The Davall Gear Company Limited, Potters Bar, Middlesex (Telephone No. Potters Bar 2382). W 357

CAPACITY AVAILABLE

GREATER STAMPING CAPACITY— At lower cost. Our new 20 ton Swiss Automatic Punch Presses produce up to 84,000 finest precision stampings per hour. Capacity is also available for: Cold rolled and cold drawn Metal Sections, in self-colour or decorative finishes (strip width up to 4 in., strip thickness up to 19 SWG). Precision Strip-Slitting from 6 in. and 22 SWG down to any size required. Electrolytic Polishing of brass, nickel-silver, gilding metal and copper. Phone our Sales Manager, Burgess Hill 86505 and 2521. Hettich (GB) Ltd., Victoria Road, Burgess Hill, Sussex. W 5222

PLEASE SEND A CIRCUIT, of prototype or production item for quotation. Full facilities available. Sheet metal chassis, panels, turned parts. Coils, transformers, cable forms, tag boards and chassis wiring, valve or transistor. Lunartron Electronics Ltd., 42 Langley Street, Luton. Luton 1111. W 2048



AEI TRANSISTOR BETA TESTER TYPE R2446

Checking transistors can be tedious and time-wasting. Or it can be speedy, easy—but accurate—even when performed by unskilled personnel . . . as with the AEI Transistor Beta Tester. The instrument is simple, inexpensive and designed for the testing of both PNP and NPN types. It gives a direct measurement of the short circuited current gain (β or α') within a range of 10-150 at set collector currents between 0.5mA and 5mA, and also of the leakage current ($I_{co'}$) of transistors in common emitter connection. In addition, particularly 'noisy' transistors can be detected. The instrument is battery operated, and the transistor under test is connected by means of quick-release terminals. The die-cast case is attractively styled, with dark grey hammer finish and light grey knobs.

Dimensions: 7¼" x 6" x 2½" approx.

Weight: 3 lb. approx.

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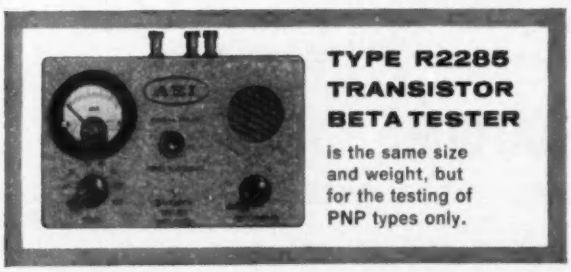

TYPE R2285 TRANSISTOR BETA TESTER

is the same size and weight, but for the testing of PNP types only.

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TA 17/101

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Windscale and Calder Works, and Chapelcross Works require experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television and industrial instruments used for the measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training Courses in Specialised Techniques are provided for successful applicants having suitable instrumentation background. Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion prospects are good.

Applications to:—

Works Labour Manager, Windscale and Calder Works, Sellafield, Seascale, Cumberland.

or

Works Labour Manager, Chapelcross Works, Annan, Dumfriesshire, Scotland.

electronic engineers

seeking a permanent post with good career prospects in a progressive organisation may find here just the opportunity they want.

A wide variety of extremely interesting and advanced work is undertaken which offers full scope for original circuit design, particularly in the field of semi-conductor applications, and for high grade skill in engineering development where a fresh and vital approach is always encouraged. Activities also include basic systems study and the design of light electro-mechanical mechanisms.

The Company is jealous of the high reputation it has earned for excellent quality design work, and only those who have the ability, qualifications and experience needed to maintain this standard are asked to apply. Generous salaries will be paid to those who match up to these requirements.

The usual amenities are available including a pension scheme with life assurance, canteen, car park, sports and social club, recreational facilities, 38½ hour week, good holidays and sickness benefits. Working conditions are exceptionally congenial with clean premises, amply provided with modern equipment, and pleasant country surroundings.

If you are of British nationality and think you would do well in such an organisation, the Chief Engineer would be pleased to talk things over in strict confidence.

Call, write or telephone:

COTTAGE LABORATORIES LIMITED
Portsmouth Road, Cobham, Surrey
COBHAM 3191

WITHOUT FAIL

The Whole Year Through *for 36/-*

For this small sum "Electronic Engineering" will be delivered to you on the last Friday of every month for a year. Be sure of a regular supply of the industry's leading technical journal by filling in the coupon, and either handing it to your newsagent or sending it direct to:—

Electronic Engineering

28 ESSEX STREET, STRAND, LONDON, W.C.2

I enclose 36/- as a remittance for 12 issues of "Electronic Engineering".

Name .....

Address .....

Signature.....

IN CANADA

EXCITING THINGS ARE HAPPENING UNDERWATER

. . . as you'll discover if you join Canada's foremost underwater electronics group.

To those aware of the need for specialization . . . who can offer underwater electronics experience in Sonar or Asdic engineering . . . these career opportunities exist:—

DESIGN AND DEVELOPMENT ENGINEERS—to consolidate 25 years of progress and advance the state-of-the-art. Must possess proven or demonstrable above-average ability in some underwater electronics discipline (acoustic propagation, transducer design, signal processing, or general circuit networks).

Equally responsible positions also exist for **PRODUCTION ENGINEERS . . . INSTALLATION ENGINEERS . . . TECHNICAL WRITERS** . . . with several years relevant experience.

Locale is Southern Ontario. Salary ranges, as befits a technology with excellent short and long term prospects, are realistic and attractive, determined chiefly by u. w. e. experience. Additional credit is given for trade or student apprenticeship, type of degree or diploma held, relevant industrial or post-graduate work, control of projects, publication of papers, etc.

Send comprehensive personal resume in confidence to:—

Box W 5275

U.K. interviews will be arranged. All applications promptly acknowledged.

THE DIGITAL ENGINEERING COMPANY LIMITED

(A subsidiary of Allan West & Co. Ltd.)

has vacancies with good starting salaries and excellent prospects for

PROJECT ENGINEERS
JUNIOR TECHNICAL SALES ENGINEERS
ELECTRICAL DRAUGHTSMEN

D.E. was started 5 years ago by 2 engineers who thought they could stand on their own feet in the fields of information handling and kindred digital subjects. They succeeded, and the Company is now competent to supply digital information handling and control equipment for a wide variety of industrial applications.

The Company is now to be rapidly expanded. If you can think clearly have a qualification in electrical engineering or electro-mechanical drawing and wish to become a member of a closely knit enthusiastic, hard working team which is certainly going places, write to the Managing Director, Dr. L. N. Bramley at 136 Battersea Park Road, Battersea, S.W.11, enclosing details of training, qualifications and experience in chronological order.

BISRA

A PHYSICIST OR ELECTRONIC ENGINEER

An attractive opening exists in the Physics Department, Instruments Section of the British Iron and Steel Research Association at their Battersea Laboratories for a graduate to work on the origination and development of measuring, inspection, and quality control techniques for use in the steel industry. A young graduate, preferably with some research experience and with a flair for electrical physics or electronics will find excellent opportunities for widening his experience and showing ability to do original work.

The Instrument Section's work is part of a programme of work on automation research, on which a total of about 50 persons are engaged at our Battersea Laboratories.

The working conditions give staff opportunities to travel, collaborate with other research organisations, and partake in learned society activities.

A good starting salary, depending on age and experience, is envisaged and opportunities for advancement can be expected by a man prepared to use initiative and accept responsibility. The post will be superannuated under the F.S.S.U.

Applications quoting "P.I.3," and giving details of education and experience should be addressed to the Personnel Officer, B.I.S.R.A. 11, Park Lane, London, W.1.

SOLARTRON SENIOR

ELECTRONIC ENGINEERS

Our Research & Development Company is now located in new laboratories at Farnborough and several new and interesting projects are under way. Engineers with experience of transistorised digital and/or analogue circuit techniques are invited to lead or join teams in the following fields:

Correlation equipment
Digital instrumentation
Servo test equipment
Simulation and training devices

Please apply in the first instance to;

S. C. GOLDING, Group Personnel Officer,
THE SOLARTRON ELECTRONIC GROUP LTD.,
Victoria Road, Farnborough, Hants.

Plessey (in Northamptonshire)

SENIOR SALES ENGINEERS

Owing to rapid expansion we wish to make the following appointments:—

SENIOR SALES ENGINEER; FERRITES AND MATRIX.
Good knowledge and technical background required on Linear and Square Loop Ferrites together with the ability to find new fields of application for ferrite materials.

SENIOR SALES ENGINEER; MINISTRY LIAISON
who should have a sound knowledge of modern electronic applications. He will be required to liaise with Ministry Establishments on the whole range of components produced by the Division, covering Rectifiers, Capacitors, Ceramics and Ferrites.

SENIOR SALES ENGINEER; INDUSTRIAL PRODUCTS
to co-ordinate the sale of Suppression Devices, Ceramic Insulators and Ferrite Magnets.

SENIOR SALES ENGINEER; SUPPRESSION:
Qualified Engineer with broad knowledge of suppression requirements on domestic, industrial and professional equipment.

SALES ENGINEER; MATRIX
A knowledge of Square Loop Ferrite materials preferred with experience in Computer development work.

SALES ENGINEER; RADIO AND TV
with knowledge of radio components industry and preferably with connections with Radio and TV manufacturers.

SALES ENGINEER; FERRITE MAGNETIC MATERIALS
with a Magnetic material background to handle sales and applications of hard ferrite materials.

It is the Company's policy to pay generous and progressive salaries which are fully commensurate with the individual qualifications and experience offered. Cars will be provided and candidates must be prepared to travel anywhere in this country; present location consequently need not be a deterrent. Immediate entry into Life Assurance and Pension Scheme.

Please apply in confidence to the Regional Personnel Manager,

THE PLESSEY COMPANY LIMITED
Wood Burcote Way, Towcester, Northants.

quoting reference SR/6.

ELECTRONICS

DESIGN - DEVELOPMENT ENGINEERS

MINIMUM QUALIFICATIONS—H.N.C.

SALARY ***£950*** *to* ***£1,500*** *p.a.*

A few vacancies exist for qualified engineers in the Laboratory of a large firm engaged in Relayed Television Programmes. The positions call for men capable of original thought and who do not require close supervision. At least two or three years' experience is vital, though this need not have been gained in the Television field since the problems, which are challenging, embrace many facets of electronic engineering.

Applications to

Chief Research Engineer,
Research Laboratory,
BRITISH RELAY WIRELESS LTD.,
1-7, Croft Street, Deptford, S.E.8.

ENGLISH ELECTRIC VALVE CO. LTD.

Application Engineer

An interesting and progressive technical position with the staff of the Small Valve Division exists for a man with sound experience in V.H.F. communications equipment. Education technically should be to H.N.C. standard.

Experience in R.F. industrial heating would be an advantage.

The successful applicant will be required to liaise with the Company's customers on technical problems in their equipment and to advise the Small Valve Division on the use of their products. Other responsibilities will include the calibration and maintenance of test equipment and the design and development of new equipment.

Age range 25 to 45.

Apply to Mr. G. M. Smith, Dept. G.P.S., English Electric House, Strand, London, W.C.2, quoting reference number EE1597L.

LEO

DESIGN AND DEVELOPMENT

Electrical and electronic engineers are required to join a rapidly expanding company offering excellent prospects of advancement in the computer field.

The vacancies are:—

One senior and two intermediate engineers to work on the design of power supply and electro-mechanical equipments. A knowledge of light mechanisms and transistor electronics is necessary.

One senior engineer to be responsible for the choice and rating specification of components used in the electronic computer equipments. Applicants should have a good knowledge of components and be able to write concise and accurate reports.

Senior applicants must have graduate or H.N.C. qualifications in electrical or electronic subjects and intermediate applicants may be considered without such qualifications. All applicants must have experience on related work.

Successful applicants will be offered high starting salaries. There is a Pension Fund and free Life Insurance scheme. The work is located at North Acton.

Write giving details of qualifications, experience, age and present salary to:—

Personnel Manager, LEO Computers Ltd.,
Hartree House, Queensway, London, W.2.

EKCO

ELECTRONICS LIMITED
AVIATION DIVISION

Interesting new projects demand expansion of the Aviation Division design resources and opportunities exist for suitably qualified staff in the following categories:—

ELECTRONICS ENGINEERS

1. HEAD OF MICROWAVE SECTION.

An experienced Microwave Engineer is required to take charge of the group dealing with all microwave work connected with airborne radar equipments. At least 5 years' experience in aerial, mixer, duplexer and general microwave component design, together with technical education to Degree standard, is necessary.

2. SENIOR MICROWAVE ENGINEERS.

Senior Microwave Engineers are required to take charge of various aspects of the work outlined above. Technical qualifications to Degree standard, together with design experience in one or more of these fields, is necessary.

3. CIRCUITS ENGINEERS.

Several vacancies exist for Circuit Engineers with experience of pulse and similar circuits used in advanced radar projects. The work will be concerned almost entirely with transistor and other semi-conductor devices, and will provide a good opportunity for competent valve Circuit Engineers to gain experience in new techniques.

4. RADAR COMPONENT ENGINEERS.

A Senior Engineer and Engineer are required for work on specialist components such as high and low power pulse transformers, delay lines, single and three phase 400 c/s power transformers.

5. MACHINE TOOL CONTROL.

A Circuit Engineer with experience of relay logic and motor control systems is required for work on an interesting new Machine Tool Control Project. Some experience of machine shop problems would be an advantage.

For posts 3, 4 and 5, technical training to Degree or Higher National Certificate standard will be an advantage, although unqualified Engineers of proved ability will be favourably considered.

DRAUGHTSMEN

Vacancies exist for Draughtsmen of all grades, including Section Leader, for mechanical design in connection with airborne and other equipment. Apart from electronic units, projects include interesting mechanical work associated with radar scanners and drive systems for Machine Tool Control applications.

All posts are permanent and pensionable, and the Company's laboratories and Drawing Office are located in pleasant surroundings at Southend-on-Sea. Senior members of the design staff will be available for informal discussions at the London Office, 5 Vigo Street (off Regent Street), London, W.1, between midday and 7.00 p.m. on Friday, July 28th and between 10.00 a.m. and 1.00 p.m. on Saturday, July 29th.

Alternatively, applications for interview with the Manager, Aviation Division, should be made through the Personnel Manager, Ekco Electronics Limited, Priory Park, Southend-on-Sea, Essex.

All applications will be treated in confidence prior to interview.

BMEWS

Ballistic Missile Early Warning System

ELECTRONIC ENGINEERS AND TECHNICIANS

An exciting opportunity of working on the largest and most advanced Radar and Electronic Data Processing Project in Britain.
The Radio Corporation of America is the main System Contractor for the Ballistic Missile Early Warning System comprising forward sites at Clear, Alaska, Thule, Greenland, and Fylingdales, Yorkshire.
Join our team of Engineers and Technicians who will be engaged in the installation, commissioning, operation and maintenance at Fylingdales!
Engineers spend several months in the USA and in most cases a period of on-the-job training in Greenland or Alaska.
Technicians receive at Sunbury a thorough and valuable training in the up-to-the-minute techniques used extensively throughout the system.
Pay and prospects are excellent.
Opportunities exist for both engineers and technicians in the following sub-systems:

PEDESTAL AND ANTENNA: (Ref. No. SE28)
Heavy duty turning gear (Scanner weight 105 tons); Servo controlled High Torque hydraulic motors; electric prime movers; fixed and variable displacement hydraulic motors and pumps.

RADAR ELECTRONIC COMPONENTS: (Ref. No. SE26)
Very high power-multi-cavity Klystron transmitters and exciters; multichannel monopulse receivers; parametric amplifiers; multi-channel doppler equipment; automatic doppler shift compensation; digital range tracker; antenna command servos; heavy duty waveguides, diplexers, duplexers, RF switching, etc.

DATA HANDLING: (Ref. No. DTH/T)
Fixed programme computers; mechanical and optical analogue digital converters; transistorised flip-flop, ferrite matrix and transfluxor storage; Boolean logic circuits; multiplexing devices; medium speed solid-state switching drive circuitry for heavy mechanical servos.

COMPUTERS: (Ref. No. COMP/T)
IBM 7090 high-speed transistorised computers; IBM 1401 variable word length computer with high speed line printer; usual peripheral equipment including card readers, punches, verifiers, etc.

DATA COMMUNICATIONS: (Ref. No. SE31)
Dipulse and carrier data transmission system; diplexed carrier video links; line drivers; transistorised programmers.

AUDIO COMMUNICATIONS: (Ref. No. SE27)
Transistorised intercom; sound-powered telephone; public address.

AUTOMATIC MONITORING: (Ref. No. SE15)
Crossbar, relay and solid-state switching; sequential checkout, transistorised checkout data processor; radar target simulator; extensive data logging facility.

CONTROL & SWITCHING EQUIPMENT: (Ref. No. SE30)
Stepped-selector, relay and crossbar matrix switching; transistor logic circuits.

SYSTEM POWER & CABLING: (Ref. No. SE22)
Medium-capacity transformers and switchgear; 400 cycle motor-generator sets; magnetic amplifiers; Three phase bridge rectifiers; novel regulator circuits; extensive distribution system.
Also Test Equipment laboratory, Electronic Maintenance shop and supporting electrical and machine shops.

Please send brief and relevant particulars, at the same time quoting 'ob reference and source of information, to the:

Personnel Manager

Special Projects Division

Application Forms will be sent in reply

R C A GREAT BRITAIN LIMITED

An Associate Company of Radio Corporation of America

Lincoln Way, Windmill Road, Sunbury-on-Thames, Middx.

ELECTRONIC ENGINEER

required for development of transistor circuits.

Age 20 to 28.

Progressive and permanent position.

Commencing Salary £1,500 to £1,800 p.a.

Contributory Pension Scheme.

Box No. W5215.

SOLARTRON

TRANSDUCERS

We are expanding our transducer development programme and wish to appoint a Group Leader to control the whole activity.

He will need to be an outstanding creative engineer with the ability to design and develop various forms of transducers and associated equipment for industrial and process control applications.

The necessary background is a degree or equivalent professional qualification backed up by at least five years' experience in one of the following fields:

precision electrical . mechanical or physical measurements . transducers of advanced design.

Senior engineers whose experience does not quite meet this specification but who would like to join the group are also invited to apply.

Please contact S. C. Golding,

Group Personnel Officer,

THE SOLARTRON ELECTRONIC GROUP Ltd.

Victoria Road · Farnborough · Hants.

TECHNICAL REPRESENTATIVE

The Technical Services Department of S. SMITH & SONS (ENGLAND) LTD., wish to appoint a Technical Services Representative for liaison work on aviation instrument equipment.

Practical experience and theoretical knowledge of aircraft instruments and electronic equipment is essential together with O.N.C. in electrical or mechanical engineering. Age under 30 for preference.

The person appointed will be required to travel in the United Kingdom and abroad.

Applications will be treated in strict confidence and should be made in writing, quoting reference SM353, to:—

Personnel Manager

S. SMITH & SONS (ENGLAND) LTD.,

Cricklewood, London, N.W.2

or telephone GLAdstone 3333, Extension 132, for further information.

CANADA

A National Electrical Service — Northern Electric Company Limited

SCIENTISTS, ENGINEERS REQUIRED

RESEARCH & DEVELOPMENT LABORATORIES OTTAWA, CANADA

Ph.D., M.Sc. in Physics and Physical Chemistry or Metallurgy or similar fields with some experience in semi-conductor processing and techniques or semi-conductor development, or similar experience.

M.Sc. or B.Sc. or equivalent degree, in all branches of engineering and science with two to four years' experience in one of the following classifications:

1. Semi-conductor design or production with some knowledge of solid state physics and metallurgy.
2. Machine design and mechanised products and handling methods.
3. Semi-conductor packaging materials and techniques (molecular electronics).

Interviews to be arranged in Great Britain.

Attractive Salaries — Passage paid to Canada

Write giving FULL DETAILS OF

EDUCATION, EXPERIENCE AND INTERESTS TO

Northern Electric

COMPANY LIMITED

COLLEGE RELATIONS DEPARTMENT

BOX 6123 MONTREAL, QUEBEC, CANADA.

Opportunities

IN SEMI-CONDUCTORS

In connection with our expansion and new development we wish to appoint immediately

2 SEMI-CONDUCTOR DEVICE DEVELOPMENT ENGINEERS

2 SEMI-CONDUCTOR TECHNICAL PROCESS ENGINEERS

These appointments will be concerned with the development and manufacture of Silicon Rectifiers and associated Semi-conductor products and will appeal to Engineers with a basic training in Physics and Chemistry to H.N.C. or Graduate level, or experience in electronic component development. This is a good opportunity for men who wish to gain additional experience in Semi-conductor techniques in a modern plant in pleasant country within easy reach of London, and affords opportunity for contacts with the extensive Research Institutions of the Company and in particular with our Licensors in the United States.

Good salaries will be paid in line with experience and ability and immediate entry into the Superannuation and Life Assurance Scheme will be arranged.

Plessey

Apply in confidence to the Regional Personnel Manager,

Towcester Components Division, The Plessey Company Limited, Towcester.

COMMONWEALTH OF AUSTRALIA

AERONAUTICAL RESEARCH LABORATORIES

ELECTRICAL TRANSDUCERS

The Department of Supply invite applications for the following vacancy at the Aeronautical Research Laboratories, Melbourne:—

POSITION: EXPERIMENTAL OFFICER GRADE 1

SALARY: £1290/1620 (Australian currency). (A substantial increase may be awarded shortly.)

DUTIES: Participate in a programme of investigations on electrical transducers with emphasis on electrical resistance strain gauges. The work will include the devising and manufacture of some apparatus and electronic equipment.

QUALIFICATIONS: A Degree in Science or Electrical Engineering, or equivalent qualifications.

TRAVEL: Under certain conditions, first class air/sea transport for the candidate and dependants (wife and dependent children) will be provided by the Commonwealth.

CONTRACT EMPLOYMENT: Consideration may be given to entering into an agreement for a three (3) or five (5) year contract of employment in Australia. In this case the Commonwealth will bear the cost of return fares, together with the cost of removing the successful applicant's furniture and effects up to a maximum cost of £500 (Australian), £250 each way.

APPLICATIONS: Forms obtainable from the Senior Representative (AV114/3), Department of Supply, Australian House, Strand, London, W.C.2, with whom completed applications should be lodged as soon as possible.

Ferranti

have vacancies for

MICROWAVE CIRCUIT ENGINEERS

to assist in new projects on parametric amplifiers in the Company's expanding

ELECTRONICS DEPARTMENT

Candidates should preferably possess a good degree backed by suitable experience in the microwave field.

The Company's Laboratories are housed in a modern building located in pleasant surroundings on the Cheshire Boundary with easy access to rural areas. The appointments carry salaries fully commensurate with experience and qualifications. A Staff Pension Scheme and a Dependants' Insurance Scheme are in operation.

Forms of application can be obtained from T. J. Lunt, Staff Manager, Ferranti Limited, Hollinwood, Lancs. Please quote reference ASM.

COLLEGE OF ADVANCED TECHNOLOGY, BIRMINGHAM

DEPARTMENT OF ELECTRICAL ENGINEERING

Applications are invited for the following posts:

RESEARCH FELLOW in new semi-conductors and dielectrics, development of new magnetic materials and annealing processes or in the field of control engineering.

RESEARCH ASSISTANTS in new semiconductors, insulators, new magnetic materials control engineering measurements, or new instruments.

Candidates for the Research Fellowship must either have shown exceptional promise in research in science or technology, or in industrial experience relevant to the proposed subject for research. They should possess a good first degree, and a higher degree gained as the result of research work; or possess a college associateship or Diploma in Technology or appropriate professional qualification followed by exceptionally valuable and interesting industrial experience, or appropriate research work in industry, research associations or government establishments. Candidates should submit their own research proposals for consideration. The appointment will be normally tenable for three but not more than four years.

Candidates for Research Assistantships should possess a Diploma in Technology, a university degree or equivalent qualification. The research work carried out may normally be sumbitted for a higher degree or other appropriate alternative higher qualification. The appointment will normally be tenable for two years but may be renewed for not more than one further year

Salary Scales: **RESEARCH FELLOWS** £700-£1,150 with graduated and training allowances where applicable. Further details can be given on the basis of the applicant's biographical data. As an indication, it may be noted that an applicant with a good honours degree, or a Ph.D. gained as the result of five years' approved full-time study would have a starting salary of about £955.

RESEARCH ASSISTANTS £600-£650

Further particulars and forms of application from the Bursar, College of Advanced Technology, Gosta Green, Birmingham, 4. Applications to be received within 14 days of this advertisement. Please quote 561/T.

K. R. PILLING,
Clerk to the Governors.

HAWKER SIDDELEY AVIATION

AVENUES TO WEAPON RESEARCH

TECHNICIAN

IN THE

TEST DEPARTMENT

There is more than one way in which you may have become qualified for a post as Technician in the Test Department of our Weapons Research Division. You may have completed or be about to complete service in the armed forces in which you have been trained in radar, wireless, or instruments . . . you may be an O.N.C. (Electrical) with experience of electronics . . . you may have a City & Guilds Telecommunication Certificate or similar qualification. On the other hand you may have no formal qualifications but provided you have had at least three years' experience of testing electronic components or experience in testing hydraulic components, we will be equally interested to hear from you. The work includes the testing of electronic assemblies, servo-mechanisms and instruments. There is plenty of scope for advancement and salaries are commensurate with your qualifications and experience. The Division is located at an airfield in a pleasantly rural part of Cheshire with good facilities for housing, shopping and transport. A superannuation scheme is in operation and there are good canteen facilities.

If your own career has been along any of the above avenues you are invited to apply, quoting reference R.236/B, to:—

The Personnel Officer,

A. V. ROE & CO. LIMITED, *Greengate, Middleton, Manchester*

A. V. ROE & CO. LIMITED

APT. ELECTRONIC INDUSTRIES LTD.

Electronics Engineers interested in developing circuit techniques employing solid state devices are invited to apply for an interesting vacancy.

Applicants are required to have a minimum of 5 years' experience covering Stabilised Power Supplies, Inverters and Switching Circuits. Academic qualifications are desirable but not essential for an engineer of proven experience.

The Company provides excellent facilities, a non-contributory pension scheme, generous salary scale and 3 weeks paid holiday.

Applications in writing should be addressed to:—

MR. D. A. BARNES,
APT. ELECTRONIC INDUSTRIES, LTD.,
CHERTSEY ROAD,
BYFLEET, SURREY.

AEI

Telecommunications Division
TRANSMISSION DEPARTMENT

Further expansion of the Department under the Chief Engineer, J. A. Pim, B.Sc.(Eng.), Ph.D., M.I.E.E., requires a number of highly competent Senior Engineers of above average ability. Positions are available in the following fields:

Carrier Transmission Systems

Pulse Circuits

Transistor and Valve Circuits

Passive Networks

Equipment Engineering and Preproduction

Technical Writing

Only fully qualified men with several years appropriate background will be considered. Experience in the control and organisation of staff will be desirable in certain instances. Salaries will be attractive to those already in senior positions, who desire wider scope for responsibility.

Applications giving full details of age, experience, qualifications and salary, should be addressed to the Chief Engineer, Transmission Department, ref 730/10 (EE), Associated Electrical Industries Ltd., Woolwich, London, S.E.18.

ENGLISH ELECTRIC · STAFFORD

INDUSTRIAL AUTOMATION

We are expanding our team engaged on the study and design of automatic control and data processing systems for industrial processes and plant—particularly in the iron and steel industry. Vacancies exist for men of high ability to undertake the following work:—

1. **Application of computers to process control.**
2. **Design of information handling and data processing systems to aid production.**
3. **Application of computers to production planning and control.**
4. **Operational research applied to heavy industry.**

We would prefer applications from men with Honours Degrees in Engineering Physics or Mathematics, but we will also welcome men with Degree standard only. Experience in the particular field stated is desirable but not necessary and training will be provided in suitable cases.

Advanced work exists immediately for experienced men and successful applicants will be joining a leading team in this field. The work will appeal particularly to young qualified engineers and scientists between the ages 25 and 35 who enjoy meeting people, selling technical ideas while at the same time doing a job requiring high technical ability. Travel to various parts of the U.K. is normal and travel overseas is often necessary.

Full details of housing and removal assistance will be given at interview and applicants should write giving full particulars to the **Technical Staff Officer, Department G.P.S., English Electric House, Strand, London, W.C.2.** Please quote reference 1206.C.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

TWO EXPERIMENTALISTS IN APPLIED PHYSICS

are required by

THE RADIOCHEMICAL CENTRE

(Ref. 5/61/42) An Experimental Physicist is required at Amersham to lead a team engaged on the operational control of radiological exposure. A wide variety of alpha and beta emitting nuclides are handled and protection measurements include breath sampling and gamma spectrometry.

(Ref. 8/61/42) An Experimental Physicist is required for the Isotope Production Unit at Atomic Energy Research Establishment, Harwell, to take charge of a small physics team whose work includes the provision, maintenance and calibration of all electronic measuring equipment used by the Unit, the measurement of pile flux and the radiation characteristics of materials after irradiation.

Applicants must be over 26 years of age and a pass degree in Physics or a Higher National Certificate in Applied Physics is desirable. For the first post operational experience in Health Physics and, for the second, experience in experimental nuclear and radiation physics and some knowledge of electronics are desirable.

The appointments will be in the grade of Experimental Officer and starting salaries will be based on experience within the range of:—

£1,165 — £1,430

Both posts are Superannuable and financial assistance may be given towards the purchase of a house.

Apply to the Personnel Officer, the Radiochemical Centre, Amersham, Bucks, quoting the appropriate reference.

LEO

DRAUGHTSMEN

Opportunities exist in the Drawing Office of a rapidly expanding Company where the prospects of advancement are excellent. The vacancies are:—

One senior draughtsman and one senior checker with experience of electro-mechanical and electronic equipments, preferably with qualifications to H.N.C. standard. The checker should preferably have experience of printed circuits.

One intermediate draughtsman with similar experience but probably qualified to O.N.C. standard.

Successful applicants will be offered high starting salaries. There is a Pension Fund and free Life Insurance scheme. The work is located at North Acton.

Write giving details of qualifications, experience, age and present salary to:—

Personnel Manager,

LEO COMPUTERS LTD.,

Hartree House, Queensway,

LONDON, W.2.

ELECTRONICS

Electronics Development, Testing, Installation, and Service Departments in our Company are expanding rapidly and we have several interesting vacancies. Some are suitable for men with good experience and knowledge of electronics to H.N.C. Standard, others for young men with a knowledge of basic principles and the ability to learn rapidly.

We make a wide range of optical/electronic instruments used in many industries at home and abroad, and are prepared to give training where necessary.

Installation and Service Engineers must be willing to travel abroad if necessary.

Write to the Personnel Officer,

Hilger & Watts Ltd.,

98 St. Pancras Way, LONDON, N.W.1.

DEVELOPMENT ENGINEERS

Required for new projects in electronics and radio, also for audio and tape work.

A minimum of two years' experience plus academic qualifications is desirable, although proven ability is more important. These positions will be filled by men interested in a broad field rather than by specialists, and a 4-figure salary will be paid to Senior men. Superannuation and usual facilities exist.

Applications to:

Personnel Dept., G.B., R.C.A., Great Britain,
Lincoln Way, Windmill Road,
Sunbury-on-Thames.

PIRELLI - GENERAL CABLE WORKS LTD.

Have the following vacancies in their

Engineering Department

1) Technical Assistant

for Telephone and High Frequency Cable Design

After training by the Company in cable design, manufacture and testing, the person appointed will be responsible for framing specifications for transmission requirements and for all technical aspects of cable construction and electrical characteristics.

Applicants, preferably in the age range 21-26, should be of H.N.C. standard or its equivalent in Telecommunications.

2) Technical Assistant

for High Frequency Measurement

Applicants should preferably be in the age range 25-30 and be of H.N.C. standard in Telecommunication Engineering. Experience of High Frequency measurement will be a further advantage.

3) Cable Technologist

To be concerned chiefly with paper insulated power and telephone cables involving the development of new cable types and processes. Investigation of cable manufacturing probelms and the preparation of technological instructions to the factory requiring the capacity for individual creative work.

Candidates should have either a degree or H.N.C. Experience of paper cable manufacture would be a considerable advantage. Age range 22-28.

Letters of application giving full details of qualifications and experience should be addressed to the

Personnel Manager,

Pirelli-General Cable Works, Ltd.,

Southampton.

EE 36 240 *for further details*

"SPEEDIVAC"

12E8 VACUUM COATING UNIT

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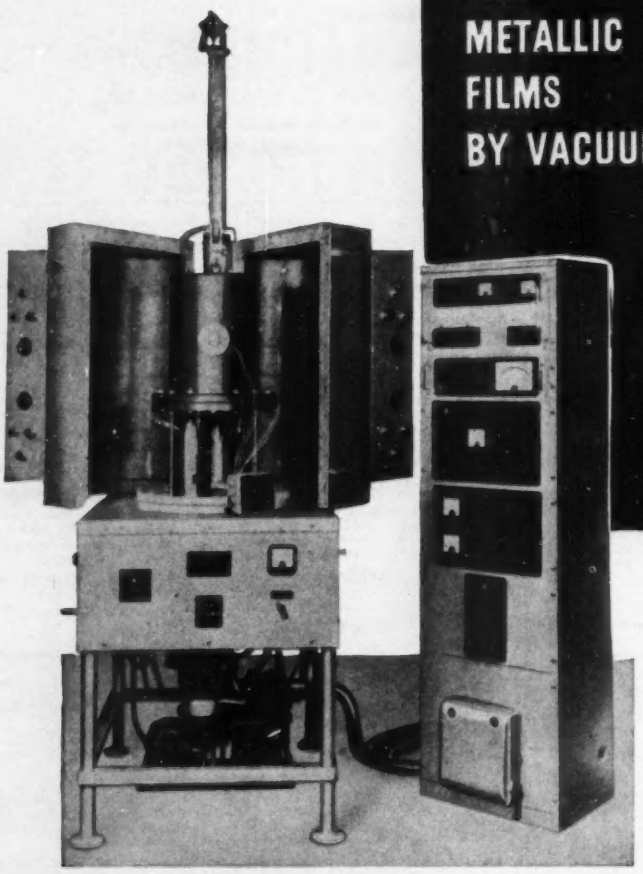

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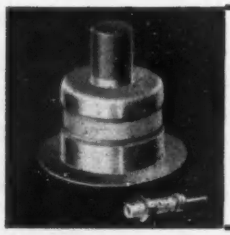

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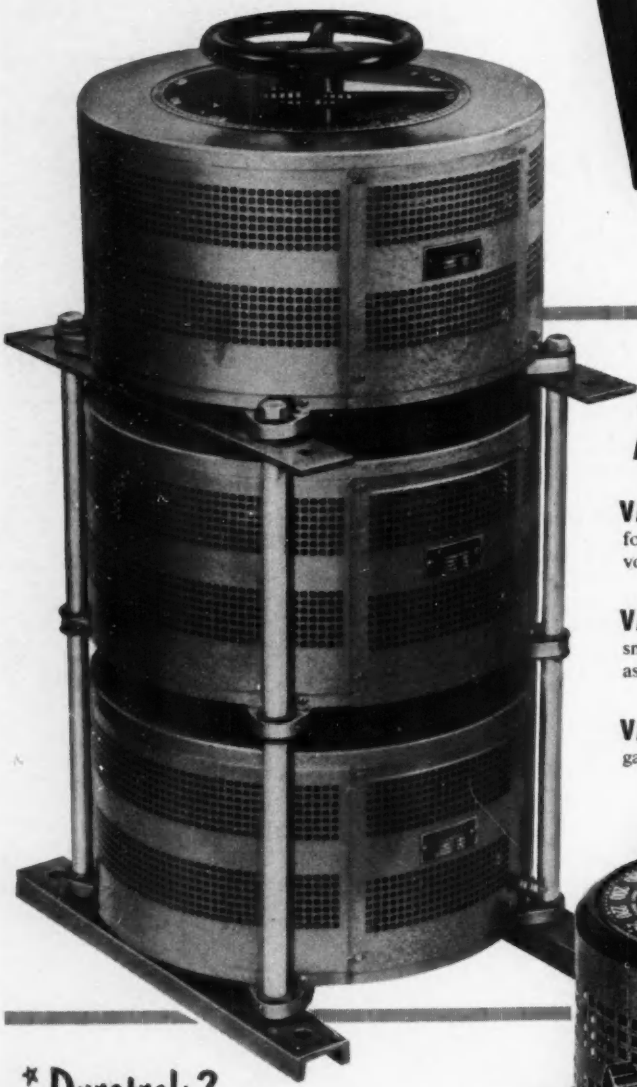

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